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PLATE I.

A. J.

A Plant of Rhea (overmatured) (*Boehmeria nivea*).

RHEA EXPERIMENTS IN INDIA.

By BERNARD COVENTRY,

Director, Agricultural Research Institute, Pusa.

Ramie, Rhea or China grass are the names under which this fibre is known. So much has been written about it in recent years, and success has so often eluded the grasp of the experimenter, that it is with some hesitation I am induced to add to the literature already existing. As however interest in the fibre appears to be reviving, the moment would seem opportune for an account of its position in India at the present time.

Rhea is not indigenous to India as is very commonly supposed, its native habitat being China, but it crept into India through Burma and Assam, and became established for a time in parts of East Bengal, where in certain localities near Rangpur it may still be found. It however never became an important industry, but was grown in very small patches, its use being confined to the making of fishing lines and nets. The cultivation of rhea as an indigenous industry need not, therefore, detain us.

Early Experiments.

Throughout the early half of the last century, numerous efforts were made by the East India Company to introduce rhea as a textile staple, and later the Indian Government considered the fibre of such importance that in 1869 two prizes of £5,000 and £2,000, and again in 1877 prizes of £5,000 and £1,000 were offered for machinery or processes by which the fibre could be prepared in such a way that it would meet the requirements of the market. Competitive trials were made at Saharanpur in 1872 and 1879, but no machine was found to satisfy the conditions of success. All these endeavours failed, and the Government's offer of prizes was eventually withdrawn.

Experiments were also carried out by several European planters and companies. The Madras Presidency seems to have been selected for the most important of these. Putting aside experiments carried out on a small scale with hand decortication (for it appears useless to consider this mode of operation owing to its cost), I shall confine myself to mentioning two important attempts, the one carried out by the Glenrock Company, Ltd., between the years 1884 and 1889 on their property at Pandalur in South-East Wynaad, and the other by Messrs. Finlay, Muir & Co., on their Reading Estate in Southern India from 1887 to 1894. The Glenrock Company planted some 400 acres in the forest slopes below Pandalur village, and about 100 acres at Kullar. Two methods of decortication were employed, one by the Death and Ellwood machine, another by steaming and removing the cuticle by hand, known as the Fremy system. According to Mr. Minchin, the Manager of the Company who was specially brought out from England, "the growth of the rhea was all that could be desired; as many as six cuttings of stems were obtained in the year, where assistance could be given to the plants by irrigation. Without irrigation at Pandalur, three cuttings were obtained between the months of June and November, during which months the rainfall is about 100 inches in all. The best outturn from one measured acre in 1886-87 under irrigation during the dry months was six cuttings :—

1,384 lbs.	of stems	(8 stems to the lb.),	about	11,000	stems.
2,028 lbs.	..	(8 | do.)	..	16,000	..
4,446 lbs.	..	(5 | do.)	..	22,000	..
4,904 lbs.	..	(6½ | do.)	..	30,000	..
3,660 lbs.	..	(9½ | do)	..	25,000	..
1,605 lbs.	..	(15 | do)	..	24,000	..

18,027 lbs. (8 tons) weight of stems in the year, about 128,000 stems." The Company obtained only 3½ per cent. ribbons by the Death and Ellwood machine, and from 5 to 6 per cent. ribbons by steam decortication according to the Fremy system. The price realised is not mentioned, but we find it recorded that "the

fibre obtained at the price ruling did not pay for the cost of production, and accordingly the cultivation was given up." On the Reading Rhea Fibre Estate, the experiment was made on a fairly extensive scale by Messrs. Finlay, Muir & Co. The highest yield of green stems was 64 cwt. 3 qrs. per acre from one cutting, from which about 7 per cent. of dry ribbons were obtained, but this was found to be an unprofitable return, and this experiment was also abandoned. These seem to be the only two attempts carried out in India on any serious scale until the more recent enterprise started at Dalsing Sarai and other Indigo concerns in Behar under the auspices of the Bengal Rhea Syndicate. Ltd., with which I shall deal later.

Cause of Failure.

The Glenrock Company's enterprise failed, not so much from any defect in the cultivation of the plant, but because the yield of dried ribbons obtained by the Death and Ellwood machine was only 3½ per cent. and by the Fremy process 5 to 6 per cent. It is known that the yield of dried fibre on a given weight of green stems is 5 per cent. Present means of decortication generally give about 3 per cent., of which one-third is gum, leaving 2 per cent. of pure fibre. When we are told that the Glenrock Company only succeeded in extracting 3½ per cent. of "ribbons," which we know to contain only 30 per cent. of fibre, the rest being cuticle and gum, it is easy to understand how the enterprise failed, for out of a possible total of 5 per cent. scarcely more than 1 per cent. was actually obtained. The yield from the Fremy system of steaming was a great deal better, for 5 to 6 per cent. of "ribbons" appear to have been got, or say 2 per cent. of fibre. This approximates more nearly to the results given by the Faure machine at Dalsing Sarai, but the expense of the Fremy system must have been great, for otherwise there seems no reason why it should not have been persevered in.

Experiments in Behar.

The decline of the indigo trade induced the indigo planters of Behar to seek new enterprises for their capital, and in 1903

eight concerns placed a portion of their lands under rhea. At the same time a company of Calcutta merchants, styled the Bengal Rhea Syndicate, Ltd., undertook to supply the Faure machine for the decortication of the plant, and to ship and sell the produce. Contracts were entered into between the company and the concerns on joint terms, the principles of which are that the company shall supply the machines, provide and erect the buildings, bale, ship and sell the fibre, while the planter undertakes to grow and manufacture the fibre at his factory, the expenses and realizations in connection with the whole enterprise being brought under a joint account. The area covered by these contracts aggregated over 3,000 acres. As the planting and cultivation progressed, it was found that many of the localities which had been selected were unsuited to the growth of rhea, so that ultimately the area actually put down did not exceed 2,000 acres. This quantity has again been reduced considerably owing to damage caused by quite recent floods. At Dalsing Sarai greater headway has been made than at other places, and it will be sufficient for the purpose of this article if my remarks are confined to these experiments alone.

Manufacture.

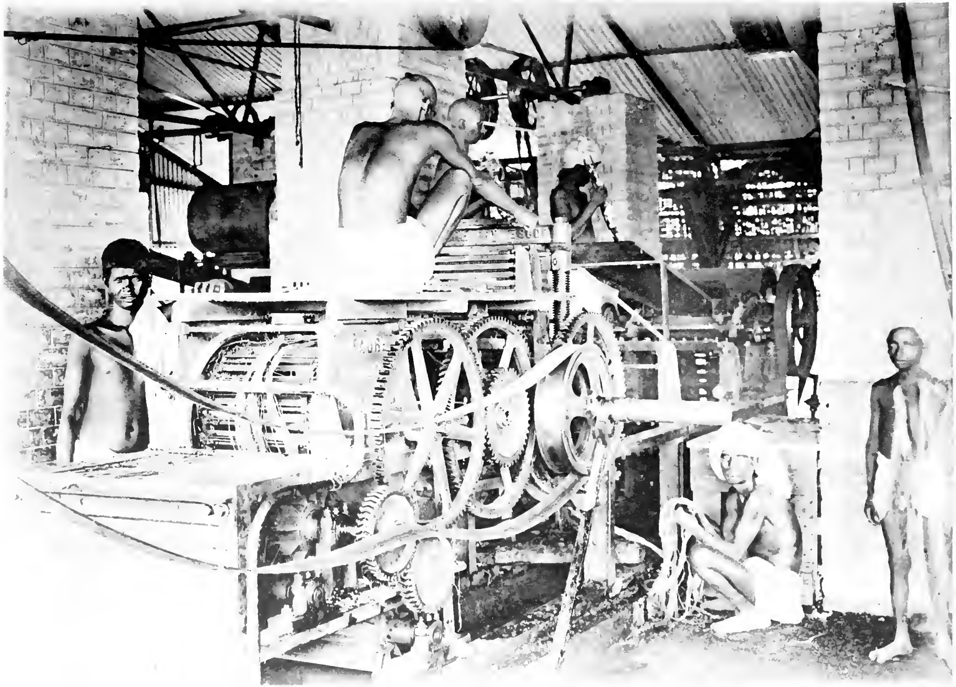
As already stated, the decorticator selected is that known as the Faure machine (plate II). These machines are of two kinds: one the ordinary machine used for scutching the butts of the stems: the other, similar to the first but with the addition of a counteraction, to which the stems after insertion into the machine are attached by the scutched ends, and by which the fibre is automatically withdrawn and delivered. In practice it is found that one ordinary machine will scutch the butts of enough stems for two counteraction machines, so that it is found convenient to work the machines in triplets. The decorticators consist of a set of beaters revolving at a speed of about 500 to 600 revolutions and operating on the stems against a counter-beater supported by suitable springs and india-rubber buffers, which cause a give-and-take to the action of the beaters as the stems are being drawn in and scutched. This enables the beaters to exert

Bemrose, Collo., Derby, Eng.

FAURE RHEA DECORTICATOR.

sufficient action on the stems to break the wood and scrape the cuticle, without snapping the fibre. This has been the chief aim and object of the inventor, and is a great improvement on the rigid counter-plate of other machines, which causes such a loss in fibre by cutting. But it should be mentioned that the Faure machine, although the best of its kind in this respect in the market, still causes a very considerable loss by cutting. In order to obviate this defect, the inventor has quite recently introduced a New Improved Decorticator (plate III) which is still undergoing its trial at Dalsing Sarai. Instead of the fibre being drawn back in the process of scutching by the automatic counteraction, it is carried straight through a set of beaters which merely break and distintegrate the wood and bark, and is then deposited on to a carrying chain, when it is presently caught at one of the ends by a comb and fixed tight on to this chain. In its progress the opposite ends are quietly dropped between the blades of a couple of drums of quick revolving beaters, and on the return journey of the chain are withdrawn. The action of these beaters is so adjusted as to cause a combined hitting and scraping motion, and is yet so regulated that the tension exerted on the fibre is not enough to break it. In this way the inventor expects to save entirely the loss by cutting experienced with the old machine. The installation put up at Dalsing Sarai consists of three sets or triplets of the old machines, and two new and improved machines. The whole is worked from a counter-shaft driven by a 20-horse power engine. Tanks at a high level for the supply of water under pressure to the machines for washing purposes have been erected, and two hydro-extractors for the preliminary drying of the fibre. A sirocco fan for finally drying the fibre in wet and cloudy weather, and a baling machine with suitable rooms for storage, have also been added. After the stems have been decorticated, the fibre is taken by coolies and washed in running water, or, if found more convenient, a jet of water is allowed to play on the beaters of the machine in the process of scutching. The action of the water is to remove a large proportion of the gum surrounding the individual fibres, which is at that

time in a soluble state and can be removed by water, but would harden and become insoluble if allowed to dry. The fibre is then placed in the hydro-extractor for five minutes, and from there it is either hung out to dry in the sun (plate IV), or if the weather is wet or cloudy, is dried by means of the sirocco fan. It is then conveyed to the store-room where the pieces of wood which may still adhere to it are hand picked, the fibre pressed into bales in which condition it is despatched to market (plate V). The quality of the fibre thus produced is variable and cannot be said to be equal to China-grass. The latter is very carefully decorticated by hand, the outer cuticle and the wood entirely removed, and the parallelism of the fibres kept intact. In other words, hand decortication as practised by the Chinese is well nigh perfect, and no machine has yet been able completely to emulate it. On the other hand, a percentage of wood and bark is always to be found in machine-decorticated rhea, and the parallelism of the fibres is impaired. In spite of this, however, spinners have expressed themselves satisfied with the quality of the produce as prepared by the Faure machine, and are prepared to take it over in any quantities. The defects referred to are easily removed in the subsequent processes of degumming, cleaning and combing, but must of necessity add to the cost. It is outside the scope of this article to discuss at length the details of these operations, and it will be sufficient to say that the spinner first sorts the produce into two or three lengths, after which it is transferred to the degumming bath where it is submitted to a combined treatment of steam and chemicals with the object of entirely removing the gum. This operation is of an extremely delicate nature, for the chemicals used to dissolve the gum would, if allowed to do so, also attack the fibre. Many processes have been invented for this purpose, some of which are patents, but others again have been kept strictly secret. Spinners at present prefer to degum, not entirely because there is an element of profit in the process, but chiefly because it is such an important part of the preparation of the fibre, and the probabilities of injury are so great, that they



Bemrose, Collo., Derby, Eng.

NEW FAURE RHEA DECORTICATOR.

cannot take the risks of badly degummed or injured fibre. For these reasons it is not at present possible, as many suppose, for the manufacturer of the raw product to degum at the factory, for he would run the risk of the whole of his produce being rejected for improper treatment. And even if we were able to degum satisfactorily, it would not be advisable for him to attempt it in the present condition of the trade. Rhea is in demand for a great variety of purposes, many of which do not require degummed fibre. He would, therefore, be narrowing his market, if he produced degummed rhea alone. After the degumming process is completed, the fibre has to be thoroughly washed until all trace of the chemicals is removed. It is then combed and made into "sliver." It is in this process that the want of parallelism in machine-decorticated rhea is felt. If the fibres are mixed, there is a greater likelihood of breaking in the combing, causing a large production of tow. Tow, however, is not waste, and unlike most other fibres, owing to the very long staple which rhea possesses, it can be worked up again and spun into yarn. The subsequent operations for spinning rhea fibre require special machinery. The writer in 1903 visited the spinning factory at Emmendingen in Germany, which at this moment absorbs probably two-thirds of the total of the world's output of the raw product. The machinery used for spinning was the invention of the proprietor, Herr Baumgartner, and had been specially constructed for him in England, to meet the peculiar requirements of the fibre. The intelligence and resource with which this work is being carried on deserves the highest praise, for it is probably far ahead of any other similar undertaking. The samples of yarn and finished product which were exhibited show the numerous uses to which the fibre can be applied. Hosiery and under clothing, brocades, pongees, damask linens and lace, gas mantles, sewing and crochet threads, light and heavy plushes, knitted shawls, and even the latest fashionable straw hats for ladies, are a few of the materials into which it can be converted. The strength and yet lightness of the fibre, and the fineness to which it can be spun, together with the fastness

and brightness with which colours cling to it, are not among the least important of its remarkable qualities.

CULTIVATION.

It is now necessary to say a few words about the cultivation of rhea. The plant belongs to the family of nettles *(Urticæ)* and to the subdivision *Bæhmeria*. There are many varieties, but two only are considered the best for fibre purposes, namely, *Bæhmeria nivea* and *Bæhmeria tenacissima*. The latter grows in tropical countries such as Java, Sumatra, Borneo, Malacca and Mexico, but will not grow well in Behar, the climate being too dry. On the other hand, *B. nivea* flourishes in temperate and semi-tropical countries, and is the variety to cultivate in Behar. The difference between the two is easily distinguished by the white woolly appearance underneath the leaf of *B. nivea*, which is absent from *B. tenacissima*.

Rhea demands that the richest lands should be selected for its growth, and they should be free from any suspicion of flooding or water-logging. If it is planted in inferior lands, disappointment is sure to follow. The object in the cultivation of rhea is to obtain a quick and vigorous growth. The stems in well established plants should be as tall as possible, from 4 to 6 feet, but never less than 3 feet. Four good cuttings should be secured per annum if it is to pay, and the total weight of these 4 cuttings of green stems should not be less than 30,000 lbs. per acre or say 15 tons. The yield of dry fibre from these stems should not be less than $2\frac{1}{2}$ per cent., making 750 lbs. per acre per annum. This amount will vary with the efficiency of the decorticating machine. The possible amount of fibre to be obtained from the stems is believed to be 5 per cent., but owing to the large amount which is broken and cut away in the rough process of decortication, only $2\frac{1}{2}$ per cent. can be relied on for an average yield with existing machinery, and this is given by the Faure machine.

The best and surest mode of propagation is from the root, though it can be grown, but with less certainty of success, from seed or cuttings. The bush intended to be used for

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DECORTICATED RHEA DRYING.

propagation should be entirely dug out of the ground, and the stool of roots left exposed for some days under the shade of a tree. Leaf buds will soon be seen to shoot from the eyes in the roots, and it is then time to transplant. The stool should be cut into pieces of about nine inches in length, with three or four buds to the piece. The land should first be thoroughly prepared and broken up to a depth of 9 to 12 inches if possible, and brought to a fine tilth. For this purpose an English or American plough is recommended. The sets should then be laid to a depth of 4 inches, 3 feet apart in a previously prepared furrow, the distance between the furrows being 4 feet. In weak lands closer planting is found advantageous. The furrows can then be covered over in the usual way. The best time of year for planting operations is July and August, when the rains have set in, as there is then less chance of failures in germination. After the sets have well sprouted, the land should be kept hoed and free from weeds, and an occasional ploughing given when necessary.

The rhea plant takes two years to establish itself, and no remunerative results should be expected until the second or third year, when the bushes have reached maturity. It is, however, advisable to cut down the bushes during the first two years of growth whenever they reach a height of 3 or 4 feet, as this will induce the roots to spread with greater rapidity. When the plant has reached maturity, it should be stripped of its leaves on the field while standing, and then the stems cut as close to the ground as possible, tied in sheaves of a foot diameter and conveyed to the decorticators. The period of growth at which to cut the plant for the best possible results is when it has attained an average height of 5 or 6 feet and some 18 inches of the bottom of the stem has turned brown in colour. The plant should never be allowed to become overmatured, for after a certain age the lateral buds on the stem begin to shoot and start a joint in the length of the main fibre, causing it to break during decortication. As soon as possible after the plant has been cut and before the new shoots from the roots make their appearance, the land should be well ploughed between the rows. A double mould-board

required would be this return of the refuse to the land. In practice, however, there will be found to be a certain amount of wastage, and this would have to be made good by the addition of a limited quantity of manure to the refuse. It thus appears that once the enterprise is established and the first quantities of refuse have thoroughly rotted, the supply of manures will not be a very expensive item. In laying out a plantation for the first time the application of organic manure is highly recommended, as it gives the young crop a good spring, and enables it to quickly establish itself.

Cost of Production.

I have already stated that 30,000 lbs. or 15 tons per acre of green stems should be obtained from four cuttings in one year, from which 750 lbs. of dry fibre can be obtained, or in other words it will take three acres to make a ton of fibre. This yield has actually been obtained over a few acres, but in order to maintain it, the very high state of cultivation I have recommended should be adopted. Whether it will be possible to secure this yield over the whole area of 500 acres under cultivation at Dalsing Sarai, has yet to be ascertained. I am, therefore, unable at present to give definite information as to results on such a large scale. But assuming that the yield mentioned will be realized, the cost of production would be approximately as follows:

Cost of producing one ton of rhea fibre per annum from 3 acres

	Rs.
Cultivation, supervision and general charges on 3 acres @ Rs. 20	60
Manuring @ Rs. 15 per acre ..	45
4 cuttings on 3 acres @ Rs. 3	9
Carting 45 tons of green stems @ As. 6	17
Decorticating 45 tons of green stems @ As 9	25
Washing and drying	10
Hand-cleaning	10
Baling and despatching	12
Engine, coal, etc. ...	30
Special establishment	20
Freight home and insurance ..	75
	Rs. 313
Price of 1 ton of fibre @ £30	450

Balance of profit on 3 acres ... 137, or say £9.

This will, therefore, give a profit of £3 or Rs. 45 per acre. Undoubtedly, there is still much room for improvement in the Faure machine, but this is only a matter of time. The real difficulty about rhea is its agricultural aspect. Is it possible to obtain one ton of dry fibre from three acres per annum? This is the vital question at the present price and with the present machine, for after all the ultimate test as to whether it pays to grow depends upon the profit *per acre*. The more acres it takes to produce a ton of fibre, the less must the profit be, and inversely the heavier the crop which can be grown the larger the profits. Now the agricultural requirements of rhea do not seem to have been thoroughly appreciated. It is not a plant that will grow anywhere. It requires well drained land and that of the best quality. It must be well cultivated, and until the refuse from decortication has accumulated in sufficient quantities in a well-rotted condition, other manures must be applied to it and, if necessary, purchased. Too dry a climate will not suit it, for to obtain four full cuttings in one year postulates a considerable amount of humidity. After a time the roots will have covered the field and an accumulation of wood will have taken place from repeated cuttings. It will then be necessary to prune the surface of the stool to induce shooting from the root. Should this eventually prove unsuccessful and the plant refuse to grow at a greater height than 3 to 4 feet, it should be dug out and a fresh plantation started in another spot. It is a mistake to suppose that rhea will grow on the same land indefinitely. Rotation is as necessary for this crop as for any other, the time for the change being determined as I have indicated.

These conclusions are based on the price at present ruling in the market for decorticated rhea, and on the present efficiency of the machine. If either of these two were to improve, naturally the agricultural question would be eased. In other words, if the machine could be made so as to yield 3 to 4 per cent. fibre instead of 2½ per cent. or if the price of fibre rose to (say) £40 per ton the profit per acre would be considerably improved, and the necessity for exacting such a high yield from the land would not

PLATE VI.

1. Raw Fibre. 2. Degummed Fibre. 3. Raw Fibre (cleaned).

A. J. I.

be so apparent. But there is seldom any use in growing a crop which cannot and is not grown at its best, and I would still maintain that if it is found impossible to grow a crop of say 15 to 20 tons of 4 to 5 feet stems per acre per annum, the enterprise should be abandoned.

PRICE.

A few words may be added about the market price of rhea. It sells at the present day in Europe at from £25 to £38 per ton. This price is regulated by the supply from China which is the over-production of an indigenous industry; the demand is from a small handful of European spinners, who appear entirely to control the trade. The total consumption of the fibre in Europe is probably not more than 3,000 tons. If a true demand arose among consumers, the amount required would be something enormous. When we consider that rhea is both a textile and a cordage fibre, and that its intrinsic merits are acknowledged by all authorities to excel those of any other known fibre, the lowness of its price is a matter for some astonishment. Cordage fibres like manila and aloe will fetch any price from £30 to £50 per ton; flax from £40 to £100; jute, which intrinsically is vastly inferior to any of the fibres named, is now fetching £22 per ton. How is it that the finest fibre in the world can with difficulty realize £26 to £38? The answer is not far to seek. A market for rhea in the true sense of the term does not at this moment exist. The supply is so small that it cannot make its influence felt, but if supplies increased to 100,000 tons, the result would be different, and I have little doubt it would be taken up with avidity. The prices would in all probability rise higher than those of flax, and we should soon see a most valuable industry placed on a firm and lasting footing. The prices which spinners are now offering for the raw product are quite out of proportion to its intrinsic merits, and the consequence is that there is no inducement for cultivators to extend their operations. The quality of the land, and the high class of agriculture required for the growth of rhea, call for a greater value for the raw product. Even if the figures

given in this article could be depended on for a cultivation on a large scale, and considering the very high quality of land which it is necessary to select, there are other crops that pay better than rhea. If spinners are truly desirous of developing this important industry, they must encourage the grower and offer a price more commensurate with the intrinsic value of the product.

THE SUGAR INDUSTRY IN THE UNITED PROVINCES.

By W. H. MORELAND, C.I.E., I.C.S.,

Director of Agriculture, United Provinces.

SUGARCANE is one of the most important field crops in the United Provinces; it occupies from $1\frac{1}{4}$ to $1\frac{1}{2}$ million acres of the superior land; it ensures regular employment to a large number of labourers at a time when other work is hard to find, and, given a good season, it enables the cultivator to pay his rent and put something by, or give his family and friends a treat. Further, it is the stand-by of the hard-working man, calling for just as much labour as he can give it, and there is perhaps no other crop which rewards skill and labour to the same degree. Any decline in the cultivation of this crop would, therefore, result in the lowering of the standard of agriculture in the provinces, while a reasonable extension is desirable in the general interests of the community. I hope to publish shortly some results of the study of this crop from the purely agricultural point of view; in the present article it is my object to indicate the relations between the cultivation of the cane and the manufacture of sugar, relations which are of the utmost importance to the future of cultivation.

Practically the whole of the crop is worked up by indigenous capital and indigenous processes. There are only two European refineries in the provinces, and the proportion of the produce which they handle is infinitesimal compared with what is dealt with by the processes which the people evolved for themselves, at a time when facilities for transport were limited and foreign competition was unknown. Now that foreign sugar has secured a place throughout the markets of the country, these processes must be

brought up to date, or the manufacture of sugar will cease to pay, and a decline in cultivation must follow.

The first process in manufacture, the extraction of the juice, is in these provinces performed by the cultivator. As a rule he needs no teaching as to the time of harvesting, the necessity of promptness in crushing, and other matters of fundamental importance; and that he appreciates an efficient crushing mill is shown by the general adoption of iron mills in place of the stone or wooden mortars which were formerly universal. But the great majority of cultivators have a very real difficulty in procuring a mill that is in fact efficient. The early mills were put on the market by responsible European manufacturers, and were in most cases efficient machines that extracted a reasonable proportion of juice from the cane, but with our cultivators' lack of knowledge about machinery, the mills very soon got out of order; usually the bearings wore unevenly, or they were altered by ignorant men, with the result that the cane was imperfectly crushed and a good deal of extractable juice remained in it. Most cultivators, however, cannot buy a mill outright, but hire it by the season. The system of hire is a really excellent arrangement, provided the person who lets out mills can be trusted to send them out in good order, and to keep them in repair during the working season; and I know of one European firm that has built up a large and profitable business on these lines, while conferring a very real benefit on the area in which it works. Unfortunately the number of reputable firms in this business is small; over a large part of the provinces the mills are owned by small blacksmiths with very little capital or stock and rather a low *morale*. These men send out their mills in a condition of really scandalous inefficiency; the cultivator has not the knowledge of machinery to enable him to detect the faults which are glossed over by a bit of polish; and if he had the skill, he would still be in difficulties, as the blacksmiths appear to avoid competition by informal understandings among themselves. In one instance I looked over the entire stock of mills set out for hiring in a town which is the centre of a large sugar tract without

finding one that was fit for use ; in another case, I examined every mill I found at work over a large tract of country, and did not find one really in working order. Taking a very low estimate, I believe that the effective yield of juice per acre could be increased by 10 to 15 per cent, if efficient mills were procurable. That good mills can be supplied as a profitable business is shown by the experience of the firm to which I have referred, and no greater reform is possible than the invasion of this business by men with sufficient capital, mechanical knowledge, and the ordinary equipment of business rectitude.

Once the juice has been extracted, there are two principal methods of treating it. In the commonest, the cultivator himself boils down the juice in an iron pan, clarifying it with such materials as are at his disposal, until the mass is ready to solidify on cooling ; the product so obtained is named *gur*, and consists of a compost of crystals and molasses. Its value depends partly on the proportion of crystals and partly on the colour and consistency which it displays ; and the quality varies greatly with the season and the skill of the individual cultivator. Most of the *gur* is eaten in that form, the balance being refined either by native process or in European factories. The individual's production of *gur* is on such a very small scale that it is very doubtful whether any great improvements are possible in the methods adopted, and the chief hope of increased profit for the *gur*-makers seems to lie in the adoption of a modification of the alternative process, which will now be described.

In this alternative, the final product of boiling is named *rab* : it is of the same nature as *gur*, but is of rather less consistency, being almost liquid instead of just solid. Most of the *rab* is made not by the cultivator but by a manufacturer ; he arranges with the cultivators of a given locality to buy their juice and sets up his boiling-plant at a convenient spot ; the cultivators work their mills at the same place and hand over the juice to him as it is extracted ; he then boils this down in a series of pans arranged over a single furnace. It will be seen that this represents a higher stage of manufacturing progress than the making of *gur* ;

the number of pans economises fuel and makes more efficient defecation possible, while the manufacturer and his servants are specialists in the art of boiling, and possess a remarkable amount of accumulated skill and knowledge. The *rab* is not a final product: it is drained, bagged and pressed by an exceedingly laborious process, yielding a sugar called *khand*, which is of a low grade even compared with most of the sugars made from *gur*, but which has hitherto commanded a large market both inside and outside the provinces.

Now the import of foreign sugars has seriously threatened the market of both this *khand* and the sugars made from *gur*: the former are of course of better quality in respect of colour and purity, and can be landed at prices which give them an advantage over the cost of sugar prepared by the methods which I have described. If then the cost of manufacturing sugar is not reduced, the indigenous industry will be killed: and if the industry is killed, the cultivator loses a large part of his market, and improvements in methods of cultivation will be of little avail when the increased produce is unsaleable. Thus the improvement of manufacturing processes is an urgent need from the agricultural point of view. Such an improvement may conceivably follow one of two lines: it may break with the past and adopt central factory methods, or it may start from the existing processes and bring them up to date. Probably there is room for progress in both directions.

The complete central factory, taking over the cane and producing sugar on the premises, has difficulties to contend with which are not found in the colonies where it flourishes. The small holdings and small fields involve the purchase of cane in half-acre lots, which means a multitude of small transactions: prompt delivery at the factory is hindered by the same considerations: the factory is more or less in the hands of the growers, for they can continue their old processes, while it must have cane: and speaking generally, the business would require a degree of organizing power that is somewhat rare in this part of the country. I do not say that there is no opening for central factories in the

provinces, but I do say that anyone who proposes to open one will be well-advised to go thoroughly into the question of organization in its local aspects.

There is probably scope for more factories taking over *gur* and working it into refined sugar. Such factories have considerable advantages over indigenous methods, provided they have sufficient capital to use modern machinery and work on a fairly large scale ; they can select their raw material, they can follow the market, and they can work up by-products to the best advantage. Apparently there is a movement in this direction on the part of some native capitalists, as I have heard that one or two refineries of this type were started near Cawnpore during the last year. Their great drawbacks from the economic point of view are that they cannot remedy the large initial waste involved in *gur*-making, and that they have to spend much money in removing impurities which should never have been allowed to enter the *gur*.

All such factories are, however, primarily questions for the business-man ; they are beyond the scope of most of the people now engaged in the trade, who have neither the large capital nor the general business knowledge required to enable them to break with the past to the necessary extent. For these men, improvement of existing methods is the only hope of saving the capital and skill engaged in the industry. As they work wholly by rule of thumb, they cannot devise improvements for themselves, and this function has fallen to the lot of the Agricultural Department. Mr. S. M. Hadi, M.R.A.C., has been working at the subject for the last five years under my general control, and his results up to 1904 were so promising that it seemed desirable to publish a preliminary account* of them ; further progress has since been made on the practical side, and there is now ground for confidence that the improved processes can be worked at a profit even after allowing for a further substantial fall in the price of sugar, a fall that would practically destroy the existing industry. A full

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* *Improvements in native methods of sugar-manufacture.* Bulletin No. 19 of 1905, United Provinces Department of Agriculture. Government Press, Allahabad.

account of these processes can be seen in Mr. Hadi's note, but the following résumé may be of general interest, both in itself and as illustrating one possible way of helping indigenous industries.

It was obvious from the start that the separation of molasses from the sugar could be done more cheaply and efficiently by a centrifugal hydro-extractor than by the slow and wasteful processes of draining and pressing; but experience had shown that the centrifugals on the Indian market gave very bad results with the *rab* prepared in the ordinary way. Thus it was necessary on the one hand to get more suitable centrifugals, and on the other to make *rab* to suit the centrifugals. In the former matter, Messrs. Broadbent and Sons, Limited, of the Huddersfield Central Ironworks, have co-operated cordially, with the result that *rab* made in a certain way can be treated with success by the machines now supplied by them. The way to make the *rab* was evolved by experiments with successive modifications of existing methods. First the pans were arranged so that juice could travel by gravity instead of having to be lifted; then copper was substituted for iron in the pans, the greater cost of raw material being almost covered by simplification of the construction; further, the arrangement of pans over the furnace had to be worked out in detail, so that each pan should get the temperature it needed, and that fuel should be economized; while, lastly, there was the question of defecation, a process which is of special importance because the use of boneblack for decolorization is out of the question, and therefore impurities must be removed at the earliest possible moment to avoid spoiling the colour of the sugar. To be a practical success, it was necessary that the materials to be used should be obtainable in country markets. A study was, therefore, made of the various defecants now used in the industry, and these were tried in the various combinations. So far it has proved impossible to use lime without getting a dark colour that renders the sugar unsaleable; and the best materials were found to be an infusion of the stem of the wild *hibiscus*, together with crude soda salts known as *sajji*, the latter being used in very small quantities. It is found by experience that

the use of these materials, applied in accordance with the methods that have been worked out, gives a perfectly clear liquid, which can be concentrated to any desired extent, and which yields a *rab* much clearer in colour and with a higher proportion of crystals than is obtainable by the existing processes—a *rab* which can be treated successfully by the centrifugals when worked either by hand or by steam. Further, the results were such that at present prices a factory on the ordinary scale could pay for the centrifugals required out of the first year's earnings and still retain a larger profit than is the case at present. Finally, it is now almost certain that a practical method of driving the centrifugals by bullock power will shortly be available for the ordinary manufacturer, who is apt to be afraid of a steam engine.

So far as can be judged at present, the *rab*-makers will adopt the new processes, though of course the change will be gradual, while there is a clear tendency on the part of *gur*-makers to change their methods. The *rab*-makers can usually command the capital that is necessary for the change since they are business-men, but the new processes are altogether beyond the means of individual cultivators. They are, however, peculiarly adapted to co-operative effort, and we hope shortly to be in a position to equip a few co-operative societies with the necessary plant.

In conclusion, I should like to lay stress on the fact that the greatest need for the maintenance and development of the native industry is the establishment throughout the sugar tracts of responsible agencies for the sale, hire and maintenance in good repair of cane-mills, boiling pans and centrifugals—agencies which would push their wares in a way that no department of Government can imitate, which would have a direct financial interest in the continued use of their machinery, and which would provide the trained repairers that are not to be found in the country at the present time. There is room here for the employment of considerable capital, which should yield a satisfactory profit if controlled by men of business-ability and business-rectitude.

SERICULTURAL EXPERIMENTS AT SHILLONG.

By Rai Bahadur B. C. BASU, M.R.A.C.,

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The rearing of the European univoltine silkworm at Shillong was started in 1904 at the instance of Sir Bampfylde Fuller, and the third annual experiment has just been brought to a successful conclusion.

The Shillong experiments were suggested by the successful example of Kashmir, where sericulture has attained an unexpected degree of prosperity within a comparatively short period. In order to study the climatic and economic conditions in which sericulture flourishes in Kashmir, Mr. F. C. Henniker, Director of Agriculture, visited Kashmir in the spring of 1903. He found that the climatic conditions of the Kashmir valley during the rearing season are very similar to those of the higher plateau of the Khasi Hills on which Shillong is situated. Nor did the circumstances of the Kashmiris appear to be materially different from those of the Khasias, both being peasants with whom the cultivation of the soil is the principal source of livelihood. But Kashmir has one advantage which is denied to the Khasi Hills, and which indeed very few countries in the world seem to possess, *viz.*, an abundant supply of wild mulberry leaf in its State forests, which the rearers are permitted to gather free of cost. The possession of this natural wealth has enabled the Kashmir Government to make a State monopoly of the trade in silkworm cocoons. The rearers are bound to deliver the whole of their cocoon crops to the State factories at a fixed price—Rs. 15 per maund of 88·18 lbs. of green cocoons—which is about one-fourth of the price they might command in the open market. The cost of the mulberry

leaf is undoubtedly the predominant factor in the cost of production of cocoons ; and as the leaf costs nothing to the Kashmiri rearer beyond the labour of gathering it, he is able to accept a low price for his produce. But this system cannot be introduced into the Khasi Hills or in any country where the rearer has to grow the mulberry leaf at considerable expense, and will naturally claim the liberty of selling his cocoons in the best market.

The Shillong rearings have been made with seed annually imported from France and Italy. Unlike the eggs of the multivoltine Indian silkworm, those of the univoltine European moth require to be exposed during the winter to a certain degree of cold, for otherwise the eggs fail to hatch evenly and the worms suffer in vigour and health. It was at first feared that the winter temperatures of Shillong might not be sufficiently low for the proper hibernation of the eggs of the European moth. It is considered essential that the eggs should not be exposed continuously for a fortnight during the hibernating stage to temperatures above 50° F. : otherwise the worm in the egg begins to unfold, and once this unfolding has begun, it cannot be stopped without danger to the life of the insect. A daily record of the temperatures of the house in which the European seed was kept at Shillong during the last winter shows a range of temperature between 38° and 60° F. during the winter. It invariably fell in the morning below 50°, and rose in the afternoon almost daily above that point, but the result of hatching was by no means unsatisfactory. The eggs hatched with perfect regularity in an incubator, and the worms did not appear to suffer in any manner from deficient vigour or health. The fear of insufficient hibernation has thus proved to be groundless.

The incubator was roughly improvised out of a wooden box. It was heated with a small kerosine stove, over which was kept a pan of water. A few inches above the pan was a chamber about 4 inches deep, with a perforated bottom on which the eggs were laid out thinly for hatching. The chamber was covered with a piece of cardboard laid loosely on the top. The warm vapour from the pan rising through the perforated bottom

kept the temperature of the incubating chamber between 70° and 80° F.

The annual importation of seed from a distant foreign country cannot be regarded as a satisfactory arrangement. The attempt made a few years ago in Kashmir to use local seed ended in a disastrous failure. A similar attempt made in a very much smaller scale last year at Shillong also gave unsatisfactory results, the parent moths on examination under the microscope proving to be infected with the germs of *pebrine* and *flacherie*. A fresh attempt is being made this year under the care of a trained sericulturist, who will attempt to produce disease-free seed by the system of microscopic examination of the moths, but it has yet to be seen whether this will be successful.

The seed imported for the Shillong experiments leaves Europe some weeks before the setting-in of the winter, for it is not safe to import seed later in the year. If the eggs are hibernated in Europe, they are liable to hatch prematurely as soon as they experience the hot weather of their passage through the Red Sea. But no such untoward result follows if the seed is sent out in September or earlier, when the thermometer still remains above 50° F. Once the thermometer falls below that point, so that the eggs enter on the hibernating stage, it becomes unsafe to expose them again to a higher temperature until the time arrives for regular hatching.

An important point to determine was the suitability of the local varieties of mulberry for the feeding of the European silkworm. There are three distinct races or species of mulberry in the Khasi Hills. Two of these appear to be exotic, and are at present cultivated for the sake of the fruits which they yield; the third is indigenous to the country, and occurs sparsely among the pine forests on the higher plateau of the Khasi Hills. Of the two cultivated forms, one has a large, round, obtuse leaf with a somewhat crumpled surface. It bears the botanical name of *Morus atropurpurea*, and is said to be closely allied to *M. alba* which is the tree on the leaves of which the European silkworm is fed. The other is *M. indica*, which has a smaller

leaf, broad at the base and tapering to a point, with a smooth surface. The same plant, or a very closely allied species, is grown extensively in the silk-growing districts of Bengal. These two forms of cultivated mulberry are generally called at Shillong the 'big-leaf' and the 'small-leaf' mulberry, and it is under these names that they will be mentioned in this article. The third or wild form of mulberry has a small, deeply incised leaf, and the branches of the tree hang down in a scandent fashion, rendering it somewhat ill-suited for cultivation. The wild mulberry leaf was largely used for feeding silkworms in the first year's experiment, and no visibly bad result appeared to follow, perhaps because it was used in combination with leaves of the cultivated mulberry. In 1905, some worms were fed exclusively on the wild leaf, but the cocoons were of decidedly inferior quality to those obtained from the use of the cultivated mulberry. In the present year's experiment, the use of wild leaf was consequently abandoned.

Both forms of the cultivated mulberry have proved suitable for the feeding of the European silkworm. In the first two years, the 'big-leaf' mulberry was considered the more suitable of the two; but this year, owing to some cause which is not clearly understood, the worms fed on the 'big-leaf' appeared to lack vigour, and the cocoons were of smaller size, though by no means inferior in point of the percentage of silk which they contain. A spell of warm weather, early in February 1906, caused the mulberry buds to open prematurely. This was followed by a succession of sharp frosts, which arrested the development of the shoots, and in places killed them outright. The frosts seem to have affected the 'big-leaf' and the 'small-leaf' mulberries unequally, for during the later period of growth the leaves of the latter appeared healthy and of the usual size, while those of the 'big-leaf' were shrunken and smaller than their normal size. That the size and weight of the cocoon were affected by the kind of leaf on which the worm was fed is seen from the results of the examination of the cocoons of four different races of silkworms reared at Shillong in 1906.

Race of worm.	Kind of leaf used.	Average length and breadth of a cocoon in millimetres (25·2 m. 1 inch).	Average weight of a green cocoon in grams (one English pound = 453 grams).	Average weight of shell, *i.e.*, cocoon less chrysalids in grams.	Percentage of weight of shell to weight of green cocoon.
French *Var*	Big leaf ...	34·16 × 16·6	1·483	0·218	14·70
Do. do.	Small leaf ...	38·9 × 19·3	1·993	0·282	14·15
Italian *yellow*	Big leaf ...	31·2 × 16·0	1·492	0·227	15·22
Do. do.	Small leaf ...	34·2 × 17·4	1·925	0·291	15·12
Italian *white crossed*	Big leaf ...	29·2 × 17·3	1·625	0·173	13·67
Do. do.	Small leaf ...	32·4 × 18·8	1·583	0·232	14·65
Italian *cellular white* ...	Big leaf	32·9 × 17·0	1·429	0·200	14·00
Do. do. ...	Small leaf ...	38·2 × 19·3	2·093	0·291	13·90

The size and weight of the cocoon were smaller in each case with the 'big-leaf' than with the 'small-leaf,' although the percentage of the weight of the shell or silky matter to the weight of the green cocoon was very nearly the same in both. The unfavourable results that followed the use of the 'big-leaf' mulberry in 1906 may, however, be an accident of the year, and should not be accepted as proof of the innate inferiority of this kind of leaf for feeding the European silkworm.

In order to encourage the introduction of sericulture in the Khasi Hills, a plantation of mulberry trees has been started on the Government Fruit Garden at Shillong. It contains every form of local mulberry, and a large number of young trees propagated from seed obtained from Kashmir in 1903. The plantation is being gradually extended so as to make it a source for the distribution to the public of mulberry cuttings and plants. Except in regard to the Kashmir trees which have been raised from seed, the only method of propagation has been by cuttings. Slips are taken from well matured twigs of the current year's growth, and set down in a nursery in October. During the winter, the cuttings are protected from frost by a light thatch; they are transferred to the field during the following rains. The trees have been planted on two distinct systems. In the first,

which may be called the bush system, the plants are set out in rows 3 feet apart at intervals of 1 foot in the row, and the plucking of leaf commences in the second year. After each annual plucking the plants are pruned to within three feet of the ground, and are thereby induced to throw up new shoots which grow fast and form numerous buds. These lie dormant through the winter, and burst out with the approach of warm weather in early spring. The second system consists in planting the trees at much wider intervals—20 feet or more apart—and letting them grow to their full size. No plucking is allowed before the trees are at least 3 years old, when light plucking may commence. The full yield of leaf is not to be expected until ten years from the time of planting. The time is not yet come to judge which of the two systems of planting will best answer our purpose. The bush system seems indispensable when a quick return is wanted, whilst the facility with which the leaves can be gathered from bushes is an additional advantage.

Three years' experience has shown that the climatic conditions of Shillong during April and the first half of May, which cover the rearing season, are not unfavourable to the healthy development of the silkworm. The temperature inside the rearing house fluctuates at this time of the year between 60° and 75° F., seldom falling below the one or rising above the other. The average is about 65° to 70° F., which is regarded as the optimum temperature for the cultivation of the European silkworm. The air is also fairly dry during this season, though periods of wet weather occasionally intervene. Prolonged wet weather is injurious to the health of the silkworm, and it cannot be said that the climate of Shillong during April and May is wholly free from this danger. The injurious effect of such weather can be counteracted in a large measure by conducting the rearing in a dry, well-ventilated house, which should also be free from draught. The experimental rearings of 1904 and 1905 were made in a temporary shed, which was exposed to the full force of the prevailing wind, and could not be kept sufficiently dry and free from draught. A considerable loss of worms was caused by

Grasserie, a disease which is favoured by wet weather. The current year's rearing was conducted in a specially constructed rearing house, built in a sheltered situation and protected by closed verandahs on the sides exposed to the prevailing winds. The result was very satisfactory. *Grasserie* was practically absent, and not more than one hundred worms in all died through disease of any kind. It would be unfair to attribute this favourable result wholly to improved housing. The weather happened to be unusually dry during April and consequently more favourable to the health of the worms than it would be in ordinary years. But anyhow it has been seen that if the dangers of prolonged wet weather are to be successfully met, a dry and well-ventilated rearing house, secured from draughts, must be provided: otherwise great loss through disease may ensue.

Some inconvenience has been felt in drying the cocoons during the monsoon which follows closely on the heels of the rearing season. In 1904, the cocoons could not be dried fast enough to prevent the chrysalids from rotting inside; with consequent damage to the cocoons. In the following year, a drying case was used, the cocoons being placed on perforated shelves through which heated air rose from a charcoal fire placed underneath. The temperature was maintained between 80° and 100°F. The cocoons were dried in this case till they lost a little over two-thirds of their original weight. The process was a slow one, but it served the purpose well. The drying case is also being used for the cocoon crop of this year.

Coming now to the actual results of the experiments, it is gratifying to note that the better samples of cocoons raised in 1904 and 1905 were valued by a French expert at a price equivalent to about Rs. 80 per maund of 80lbs. of green cocoons, and were considered equal in point of quality to first class cocoons selling in the French market. In 1905, the worms suffered to some extent from insufficient feeding, with the result that some lots of cocoons failed to reach the standard size, but in respect of the silk contained, none of them fell below the mark. The cocoons this year's experiment have not yet been appraised; but from a

rough examination the cocoons raised on the 'small leaf' mulberry appear to be in nowise inferior to cocoons of average quality obtained in French rearings. It is possible some may rank superior to the average. The weight of a well-grown French cocoon of the variety known as *Var* is given by M. de L'Arbousset, a French authority, as under 2 grams or 2,000 milligrams. Mr. N. G. Mukerjee quotes the average as 1,850 milligrams. The average of 20 *Var* cocoons picked at random out of the lot fed on the 'small leaf' mulberry was 1,993 milligrams. Again, the percentage of the total silk-content, that is, of the shell of silk to the weight of the green cocoon, varies in France between 13 and 15, according to the character of the year. In this respect also the *Var* cocoon of Shillong with 14·15 per cent. of silk-content is fully up to the mark.

The size and weight of a cocoon varies with the variety to which it belongs. It will serve no useful purpose to compare *Var* in these respects with the other varieties of cocoons raised at Shillong. The real criterion for determining the relative merits of different cocoons is the percentage of silk which they yield. The percentage is determined by a reeling test, but where a reeling test is not practicable, it is taken to be equivalent approximately to two-thirds of the percentage of the total silk-content, the remaining third representing waste and loss unavoidably arising from the existence of 'double' and other defective cocoons. On this basis, the eight lots of green cocoons, of which the percentages of total silk-content or shell have been quoted in a preceding paragraph, would yield the following percentages of silk :—

French *Var* fed on	'big-leaf' ...	...	... 9·80
Do. do. do.	'small-leaf'	...	... 9·43
Italian *yellow* fed on	'big-leaf' ...		... 10·55
Do. do. do.	'small-leaf'	...	.. 10·08
Do. *white-crossed* fed on	'big-leaf' ...	...	.. 9·11
Do. do. do.	'small-leaf'		... 9·77
Do. *cellular white* fed on	'big-leaf' ...	..	9·33
Do. do.	'small-leaf'	...	... 9·27

Considering that green cocoons lose two thirds of their weight on drying, that the loss of weight is due wholly to the drying

of the chrysalids inside, and that the weight of silk suffers no diminution, the percentage figures given above should be multiplied three times to give the percentages of silk to the weight of dry cocoons. The lowest percentage of silk thus obtained amounts to 27·33, and the highest to 30·45. The basis of sale of dry cocoons in the French market is a yield of 25 per cent. of silk : cocoons yielding less silk on a reeling test are valued at a proportionately lower price, and those yielding more fetch a relatively higher price. The percentages in the case of the Shillong cocoons would thus appear to be better than the standard of the French market. The fact is one which may be noted with satisfaction, but it should be remembered that the figures relating to the Shillong grown cocoons are arrived at, not by an actual reeling test which alone can give the true percentages, but by a process of deduction based on the ratio between the weight of the green cocoon and weight of silk that would be *ordinarily* expected from the dry cocoon.

It has thus been seen for three years in succession that the European silkworm can be reared successfully at Shillong. The climate has, on the whole, proved favourable to the silkworm, and if it has certain drawbacks, these can be readily overcome. The winter of Shillong has proved to be sufficiently cold for the proper hibernation of the seed. The local races of cultivated mulberry have proved suitable for the feeding of the European silkworm. And last of all, the size and quality of the cocoon have not apparently deteriorated below the standards attained in France. The only part of the experiment that yet remains to be worked out is to ascertain whether healthy seed can be locally produced. Even if this fails, the price of foreign imported seed is not after all so heavy as to forbid its profitable use. The Kashmir rearings, for instance, are wholly dependent at present on European seed, of which about half a lakh rupees worth is imported annually by the State.

The problem which now lies before the Agricultural Department of Eastern Bengal and Assam is to induce the population of the Khasi Hills to take to sericulture. The industry is an

essentially domestic one. It requires little capital beyond the provision of a suitable rearing house, and no very large amount of labour in comparison with that required for the cultivation of land. On the other hand, it requires a great deal of patience, forethought and minute attention to details, and it is exacting as regards the daily operations of feeding and tending the worms, which demand immediate performance. It also requires the utmost cleanliness for its successful prosecution. Whether the Khasias possess the requisite qualifications, it is hardly possible to say at present.

There is a fairly large field for the extension of sericulture in Assam. An experiment in rearing the European silkworm made at Kohima in the Naga Hills in 1904 was attended with results quite as satisfactory as those obtained at Shillong. The small Native State of Manipur on the Eastern Frontier of Assam is already possessed of a nascent silkworm rearing industry, and the mulberry feeding silkworm has been reared in the Assam Valley from time immemorial side by side with the species which produce the celebrated *eri* and *muga* silks of Assam. There is every reason to believe that the European silkworm can be raised in the greater part of the hilly country extending from Manipur on the east to the Garo Hills on the west, as well as in every part of the Assam Valley. The circumstances of the Assam Valley seem to be particularly favourable to the introduction of the European silkworm. There are people whose caste profession is the rearing of the mulberry silkworm, who are well conversant with the indigenous methods of rearing, but who have not yet learnt the modern methods of combating the diseases of the silkworm. But the industry has greatly declined in recent years owing to the great prevalence of disease, through which whole crops of worms are occasionally lost. The Agricultural Department may well take the Assamese rearers in hand, and help them in resuscitating a decadent industry by teaching them the use of healthy disease-free seed, and of the remedies which science has placed within the command of the rearer for fighting disease. The introduction of the European silkworm may help greatly in

infusing life into the industry. The seed of the European silkworm will have necessarily to be imported from abroad, and if care be taken to obtain it from a reliable source, the risk of wholesale loss through disease which now often takes place as the result of using local seed will be minimised.

SUGARCANE CULTIVATION IN THE IRRIGATED LANDS OF THE GODAVERI DELTA.

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THE following are some of the principal results obtained from the study and growth of sugarcane at the Government Sugar Station, Samalkota. The main object of the farm was to find a means of combating the prevailing sugarcane disease. There can be no doubt that to raise healthy crops it is necessary to select good seed and to treat the canes well all through the period of their growth, and this has been much neglected in the past. But the local canes, even if well treated, have proved unsatisfactory, and it has been necessary to obtain hardier varieties with good sugar-producing properties. This is, of course, a difficult matter, but the efforts on the farm have met with some measure of success. It is confidently believed that if the advice now given is followed, remunerative crops of sugarcane can with certainty be obtained in the Godaveri delta.

Selection of Land.—The choice of land for sugarcane cultivation is of prime importance. Any irrigated land with a good water-supply may be chosen for paddy and a reasonable crop obtained, but this is not so with sugarcane. The land must be good. The cost of cultivation is considerable, and to be content with a poor piece of land is very bad economy. The piece chosen should be easy of irrigation, for the absence of water at critical periods, especially in the first few months, is likely to leave its mark all through the growing season. A cane field making a bad start never fully recovers itself. All low places, where there is a chance of water lying on the surface after heavy rains, or

such as cannot be quickly and conveniently drained after irrigation, must be avoided. In almost all cases when disease has appeared in the canes, it has appeared first and has been most violent in low, ill-drained places.

Preparation of the Land.—The ordinary ploughing is not deep enough for sugarcane in heavy land. Here crow-barring must be done wherever possible. This has the effect of aërating the soil and allowing the roots to penetrate deep, thus building up strong plants not easily affected by drought. It also helps to clean the land of weeds especially after paddy cultivation, or in such places as have *Imperata* grass on the bunds. The sods should be completely inverted in crow-barring.

Immediately before crow-barring a liberal dressing of compost, of at least 1,000 head-loads to the acre, should be spread over the land. The bunds and outskirts of sugarcane fields are usually covered by a very luxuriant mass of grass and weeds. These must be kept in check by clean cultivation, and if properly treated may become a very valuable compost. They should be frequently cut and thrown into large pits with layers of earth a few inches thick at intervals. The grass may be cut by the owners of cattle and taken away from the field, but if this is done two head-loads of weeds should be brought in exchange for each head-load of grass. If the weeds are thrown into these pits from May till December—the period of greater growth—and then covered with earth, most of the compost will be ready for the next preparation of the land. Where cattle are available the addition of urine and manure to the weeds will be of great benefit. A convenient size for the weed pits is five feet deep, four feet across and twelve feet long; but the depth will depend on the nearness of irrigation channels, as water should not lie in the bottom.

Selection of seed cuttings.—Cuttings for planting should not be taken from ratoons as these are usually more diseased than plant canes. The sets must be carefully examined when cut, and any one with the least trace of red colour should at once be thrown away. Such are diseased and will not grow into good healthy canes. Tops should be used whenever available and,

when they are insufficient, the upper part of the cane should alone be used. The lower part of the cane is more valuable than the upper for sugar-making and, the joints being closer in the upper part, the latter should be kept for planting. Many of the buds in the lower halves have also been injured, and germination has always been worse in the lower than in the upper halves of canes in the experiment on the farm. Some varieties such as *Seema* will only grow from tops.

Number of cuttings per acre.—This varies in different districts and with different kinds of canes. As a rule 10,000 per acre is sufficient for heavy lands. In some cases cultivators plant from 25,000 to 50,000 sets per acre, which is a very wasteful proceeding. In the West Indies, where the soil is in better condition and there is no irrigation, 4,000 sets to the acre are sufficient to yield a full crop. The object of sowing an excessive number of sets is to secure a full stand, but this may be easily managed with a little care by a method described below. Experiments are being tried on the farm with 5,000 cuttings per acre, and the results are thus far promising. If the number of sets per acre, can be reduced, much greater care can be exercised in their selection, and this is a matter of great importance in fighting the disease.

Planting.—Great care must be exercised in this operation. The sets must be carefully covered by at least 2 to 3 inches of earth. It is of special importance that the irrigation of newly planted land should not be excessive, as many sets are annually destroyed in this way. The first roots and leaves are very tender and must be treated very gently. They do not need much water, and it will suffice to keep the land moist instead of thoroughly wetting it.

The sets should always be planted in rows. It is the custom in the Gódáveri Delta to broadcast the seed, and this tends to much inconvenience in all the subsequent operations. A good deal of labour is saved by planting in rows, and this may be done by stretching a string across the ground and moving it along for successive rows. In hoeing with hand hoes, the workers

should walk backwards between the rows, as there is no danger of trampling the plants. The appearance of a field hoed backwards is very much better than one done forwards in the ordinary country method. Trenches are much easier to dig, and no plants are injured in trenching if the plants are in rows. It has been found by experiment that when 40 men are required to wrap the canes in a piece of land sown broadcast only 30 are needed when the canes are in rows, and this proportion of labour-saving holds good for all the operations during cultivation.

Supplying.—In spite of every precaution in the choice of seed and in planting, it has been our experience that some of the sets fail to germinate and vacant places are the result. These must be supplied. This may usually be done inside the plot itself by lifting young plants from the denser parts and planting them in the vacancies, but it has been found useful to plant a small outside strip of the field quite closely, from which the needed supplies may be obtained. The supplying must not be delayed beyond six weeks from the time of planting the field. Supplying must be done on dull days if possible, but this is not absolutely necessary. It has been found inadvisable to supply vacancies by putting fresh cuttings in, firstly because the treatment of the cuttings is different from that of young and growing plants, and secondly because the sets thus put in rarely catch up with the other plants and are smothered by them.

Ratooning.—This is the term applied to growing the cane for a second year on the same land. It should be in all cases avoided for the present. Even good *Yerra* plants which have given an excellent crop have failed miserably as ratoons. This is due to the fact that the disease enters the cane from the soil, and it is always much worse even on good land in ratoons than in plant canes. Sets for planting should not be taken from ratoons for the same reason.

Stool-planting.—There is one form of ratooning, however, which has given good results thus far. In this the roots are lifted out, cut up and planted elsewhere. The roots of canes have to be dug out in preparing the land for the next crop. If

these roots are split into two or three parts and then replanted in fresh land a very uniform result is obtained. No more than 5,000 to the acre are needed, and thus it will be seen that the roots of an acre of canes will plant up 5 acres under this system. Stool-planting may be done either before the canals are closed or after they are re-opened, and the great advantage of the system is that there are no vacancies and no supplying is needed. (See also paragraph below on Nursery planting.)

Irrigation.—This should be done at fairly frequent intervals and with moderation. In heavy land, once in ten days should suffice, but in light soils, it should be done more frequently, and will depend on the locality and whether irrigation is from wells or from channels. In irrigating, the surface of the beds between the channels should never be covered by the water. If it is thus covered, it will have to be hoed again much sooner. The water in the channels should be at least four inches below the surface of the ground in the beds. It is a good plan to let the water into the field in the evening and let it out on the following morning, but this will depend on the locality. Water should never, on any account, be allowed to lie in the channels when irrigation is not in progress.

Manuring.—This must be carefully attended to, as it is useless to try and grow sugarcane without feeding the plants. The spreading of compost before crow-barring is not manuring. It is intended to lighten the soil and to prepare it for the manure to be applied later, but it cannot replace manure. The best manure for heavy soils with plenty of water is oilcake. This varies a good deal in value with the different plants from which it is prepared. Groundnut and castor cakes are the best, but they are costly; Margosa and Pungam are not so good and Bassia is very poor. But it sometimes happens (as in the Gódáveri Delta) that it is more economical to use the cheaper cake. It should at the outset be decided how much to spend on manure, and Rs. 30 to Rs. 40 per acre has given very good results on the farm. With this amount 10 bags of castor may be purchased, but 30 to 40 bags of mixed Margosa and Pungam. The latter

has been found to give a better result. Rs. 30—40 worth of mixed Margosa and Pungam cake is the most economical form of manure yet observed on the farm. This should be supplied when water is abundant and when the plants are beginning to grow strongly, and the best time is after the re-opening of the canals. It is better to apply the manure in two doses with an interval of two months. Artificial manures such as ammonium sulphate, sodium nitrate and bone-dust have given very poor results indeed on the heavy delta soil, and the local "cattle manure" is of no value at all as a manure.

Jackals.—The canes, when approaching ripeness, must be carefully protected against jackals. These cause much damage, and help in the spread of disease. Throwing mud on the lower part of the canes is a local practice and is very good, as the jackals do not like the taste of the mud. This may be done when digging the trenches and when cleaning them out. A pan of jaggery water may also be placed in a convenient place and the jackals shot one after the other as they approach. As many as ten in a night have been destroyed on the farm in this way. It has been found that when a number of jackals are killed in this way the rest desert the field.

Planting from Nursery.—In heavy land where there is only nine months' irrigation and the cane requires twelve months to mature, it would appear to be impossible to grow sugarcane. The following plan may, however, be adopted in such cases with a fair prospect of success. Plant cane cuttings in seedbeds so close together side by side as to touch one another. The beds may be of any length and about 3 feet wide and should be separated by water channels a foot wide. The seedbeds (reminding in many ways of paddy seedbeds) should be near a pond or well and must be regularly irrigated, although they do not require so much water as fields of growing cane. They need not be manured specially if the land is good. The seedbeds should be laid down after reaping the crop and when the water in the canals is failing, and the plants should remain in the seedbed until water is again available. When the canals are re-opened the young plants

may be carefully lifted and planted out in the field. They may be put in a couple of feet apart and treated in the ordinary way. It is calculated that 8—10 cents of nursery will plant up an acre of cane, and an advantage of this method is that an even stand is obtained and there need be no supplying. The canes must now be made to mature as rapidly as possible. Excess of water must be avoided as also too much nitrogenous manure, as both of these, while increasing the growth and weight of the canes, retard the ripening process. Ten bags of castor per acre is perhaps a little too much in this case, but this matter has not been fully worked out. Wrapping the canes should be dispensed with, as the exposure of their surface to the air helps on the ripening process. Towards reaping time the supplies of water must be restricted. Provided the surface is kept stirred, no water need be given at the end of growth, and the canes may be reaped as soon as ripe. Care should be taken finally in the selection of the canes. *Sunna Bile*, *Bonta*, *Ashy Mauritius* and *Striped Mauritius* appear to ripen quickly.

Varieties of Canes.—This selection of canes is one of the chief pieces of work being carried out on the farm. A great number of canes have been brought together, and these are constantly being added to. There are about 45 varieties now growing on the farm. These have been obtained from all parts of the Presidency, from Bombay, Bengal, Mauritius and Barbados. In all cases the local Madras canes, subjected to a long course of disease, have been found inferior to the imported varieties. The new canes are being rapidly propagated on the farm and year by year distributed to the ryots. A smaller cane garden has now been established in the South Arcot district at Palur Farm. It is of course, quite impossible with these two small farms to supply all the canes asked for, but where possible a few canes at least will be sent to all applicants for experimental growth in the Presidency. These are charged for at the ordinary rates and carriage will also have to be paid. This year Red Mauritius and Striped Mauritius are being distributed, and the canes will be ready for distribution towards the end of January.

Sugarcane Disease.—A word in passing as to disease. When a cane field has been diseased, the fact should not be forgotten. In the first place, replanting canes there should be avoided for some time. Then the water which has passed through the field should not be allowed to irrigate other canes. It is very possible that the disease is usually spread largely by drainage water. The old dried pieces of canes should be carefully removed and burnt, for the spores of the fungus carrying the disease multiply in them to an enormous extent, and it is the height of folly to allow the dead canes to lie on the land again to be planted with sugarcane. Dead or sick canes should never be thrown into the irrigating channels as is often done.

Jaggery-making.—In conclusion a few hints may be given as to the manufacture of jaggery, although this is not the main purpose of the present article. There is much room for improvement in jaggery-making; but it is useless to apply general rules for its manufacture without considering the market which it is desired to supply. The jaggery made for the local bazaar is a very different article from that which is intended for export. The bazaar jaggery, unless it is immediately used, is very liable to be spoiled, and an expensive system of smoking is adopted when it is necessary to keep it for some months. With a little care, a jaggery of good colour may be obtained which will not turn soft for months. The secret of this is, first to boil the juice as soon as possible after expression, to wash the mill carefully every day, to wash the pots out after using each time with lime and water, and to leave a little lime-water in them before pouring in the juice. More lime should also be added to the boiling pan. The jaggery obtained from different canes varies a good deal. That of *Yerra* is turned brown by the rind of the cane, that of Red Mauritius remaining colourless. The jaggery of *Sunna Bile* is extremely soft and will not readily form a cake, while that of *White Mauritius* and *Seema* is noted for its bright crystalline character, and so on. This difference in jaggery should be considered in choosing your cane. The jaggery needed for refining by local factories or intended for export is a very different article

from that required for the bazaar. It must be hard and crystalline and capable of withstanding much knocking about without becoming bad. Such is only to be obtained by very great care in all the points noted above and using an excess of lime. This turns it very dark in colour and it will be of no use in the local bazaar. But in a good year the local market will be quickly stocked and the surplus must be sold to the merchants for export. It will be well then always to make the jaggery as good and hard as possible, as otherwise considerable loss will be experienced in good years. The merchants will not buy jaggery that is at all soft.

SURFACE CATERPILLARS.

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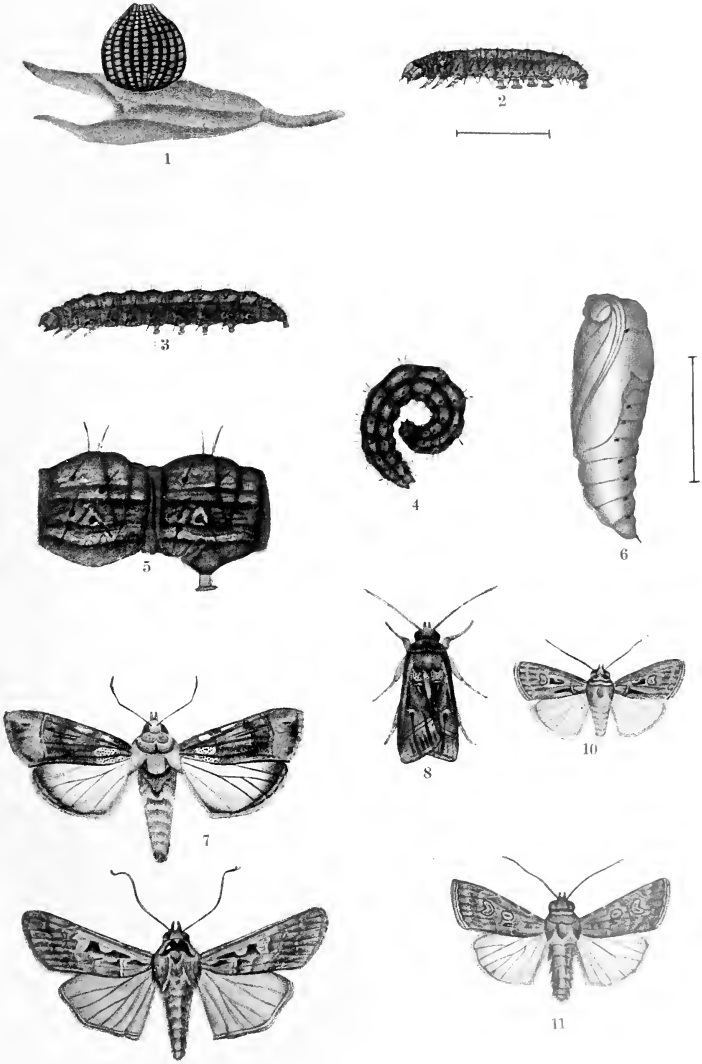
In some parts of India, if a winter crop of opium, gram or peas is sown on land that was under flood during the previous rains, it is not infrequently found that the young plants, instead of making an even growth over the field, die off in patches and fail to give a full crop. If such a field is examined, it will be seen that here and there are the leaves of the young plants cut off and sometimes buried, and a few plants will be found cut right through at the base. This is the work of Surface Caterpillars, and on a careful search for a half buried leaf one will often discover, an inch or so below the surface, a fat grey-brown caterpillar with a peculiar greasy smooth look, like the insect in figure 4 of Plate VII. If such a caterpillar is found, there can be no doubt that the irregular crop is due to surface caterpillars, or as they are called in the United States "cut worms." A cut worm is presumably a "worm" that cuts off young plants; we prefer the more accurate old English term "Surface Caterpillar," a caterpillar that lives at the surface of the soil. Surface caterpillars are an example of a pest which is readily checked by vigorous action combined with common sense. Unfortunately this pest is rarely checked in India, and the gross aggregate of loss caused yearly to cold-weather crops must be very large.

The life history is very simple and is illustrated in Plate VII. We select the commonest surface caterpillar of India for the subject of these observations, the behaviour of the other species showing only variations of detail. Eggs are laid by the moths in October on weeds in or near fields; each egg is round, most

PLATE VII.



THE INDIAN SURFACE CATERPILLARS.

Engraved and Printed by The Calcutta Phototype Co.

aptly compared to a poppy seed, with neat radiating lines and ribs, of a greenish white colour. A close observer may find a cluster of these on a leaf, not covered with hairs as are those of the allied Indigo caterpillar, but exposed. As a rule they are on the under surface of leaves near the ground, and consequently not readily found. They hatch in from two to six days and the little caterpillar emerges, looking like a miniature of figure 1 in Plate VII, but walking with something of a hump ; if undisturbed it eats the eggshell as its first meal, but if disturbed it falls off the leaf to the soil and hides. It is found under fallen leaves or any other shelter on the soil, and feeds at night upon green leaves or, if these are not available,, upon fallen leaves. As it grows larger, it moults, each moult being accompanied by small colour changes. Moults occur about every four to six days, but this depends upon the amount of food available and the temperature. When it is about half grown, it develops the habit of burying itself by day in the loose soil ; by night it issues in search of food, bites off a shoot of gram or a leaf of opium, and eats it ; as a rule a leaf or shoot is dragged into the soil where the caterpillar buries itself, and this half buried leaf often indicates where the caterpillar is. As it grows larger, it does not hesitate to bite through the base of an opium plant, for instance, eating straight in at the soil level and killing the whole plant ; this is why it is so destructive, as it destroys far more than it requires for food. The full-grown caterpillar is over one and a half inches long, rather flattened, of a dull grey-brown colour, smooth, with only very short hairs ; examined with a lens, it will be seen to have small flat black specks on the skin. After about four weeks (the exact period depending largely upon temperature), the caterpillar is full grown and buries itself in the soil deeper than usual, making a case of earth round itself so that it can turn into a chrysalis undisturbed. It remains in the ground as a chrysalis for ten days in hot weather up to thirty days in the coldest weather. The moths then emerge and spend the day in hiding under shelter, flying about at dusk. The moth is represented in figure 7 of Plate VII, and the sexes are similar in appearance.

The female lays from two to four hundred eggs in clusters which usually contain about thirty each.

If we take the average life history at about seven weeks (it actually varies from five to nine weeks), and start from the first moths emerging about October to lay eggs, there will be more than one brood during the cold weather; these broods are not regular, and at any time all stages of the insects will be found. The attack on the crops is most marked about December and early January as a rule in Behar and Oudh, but also occurs in March. The insects are destructively abundant only in the cold season on the rabi crops, and up to the present they have not been found destructive to kharif crops, except in one instance. They appear to be cold weather pests, which during the rains feed entirely upon abundant wild vegetation; this applies of course only to the plains and not to the hills. There are several species of surface caterpillar, which are figured in Plate VII. The most destructive is the one discussed above, the Greasy Surface Caterpillar (*Agrotis ypsilon*, Roth.) which is not confined to India.

Its distribution in India is a curious one; it is a pest in tracts bordering on the Himalayas, in Oudh, Behar, Northern Bengal and the submontane districts of Eastern Bengal and Assam. There is no record of it elsewhere in the plains, though its place may be taken by the other species. Its foodplants are legion, and it is difficult to find any low-growing plant that it will not eat. It has a decided preference for the opium poppy, on which it thrives, and next to this plant, it appears to prefer gram, tobacco and potato. The caterpillars also relish lucerne, celery, senji, mangold, wurzel, sunflower, cotton, bean, cabbage, radish, mustard, brinjal, plantain and several weeds. They have been reported from several districts as attacking chiefly tobacco, opium, gram and potato, and in the winter of 1905-1906 seem to have been unusually abundant. They probably occur every cold weather but are rarely reported. Three other species occur in the plains, having similar life histories and habits but being far less common as pests. The moths of these caterpillars are shown in Plate VII and are readily distinguishable. The cater-

pillars are difficult to identify, and to be sure of the identity it is necessary to rear the caterpillar to the moth which is a very easy matter.

Agrotis flammatra, Schiff. (Plate VII, fig. 9) has only once been reported as injurious with the Greasy Surface Caterpillar; it is very abundant in some localities in the plains, but is really an exotic temperate-climate species which has spread into India. Large numbers of the moths are sometimes seen in March, flying at dusk among trees and coming into lighted rooms. The caterpillars live at the roots of grasses and other wild plants as a rule, but may be found in crops.

Euxoa segetis, Schiff. (Plate VII, fig. 11) is so like the moth figured in the Journal, Vol. I, page 338 (The Indigo Caterpillar) that it is readily confused; the caterpillar is, however, quite distinct, and this moth is larger. It has been found rarely attacking crops and is another potential pest that may occur at any time. It is reported in Indian Museum Notes as attacking young coffee plants, and it is there stated that a large number were destroyed by collecting by hand. Strictly speaking, it is more a hill species, but is occasionally found in localities below 2,000 feet elevation.

The last species is *Euxoa spinifera*, Hubn. (Plate VII, fig. 10) the most common surface caterpillar next to the Greasy Cutworm. The moth is quite distinct in markings, and the caterpillar is similar but with a brown tinge and less "greasy" appearance. This species was sent in from the Gujarat District (Punjab) as destructive to young cotton plants in May 1906, and from Poona where the caterpillars were destroying young plants; it is also known to occur in Behar as an occasional pest to young indigo in April and to rabi crops.

The treatment of all these pests is the same and is quite simple. When once the damage in the field is assigned to the right course, the caterpillars are readily destroyed by simple hand-collecting, for they are not hard to find; coolies in Behar certainly know how to find them very readily, and only the dislike of taking life deters the cultivator from destroying them. In the

Pusa farm several baits were tried, of which one proved a success. It consisted of six gallons of water, into which were stirred 4lbs. of white arsenic and 8lbs. of sugar; this was very thoroughly mixed with a maund (80lbs.) of chopped straw (*bhusa*). The pasty mixture was put out over the land in small portions every two yards or so, and was sufficient for five acres. The success of this bait was amply confirmed by the finding of numerous dead caterpillars and by observation of the insects in cages. The mixture is apparently attractive, and is of course highly poisonous; if put down in quite small portions cattle are most unlikely to eat it even if they get into the field to feed freely, so that there is really no danger in its use. Whether poison be used or not there is no reason why the pest should do any damage whatever, if the cultivator will only destroy it by the perfectly simple means of collecting it; life need not be taken, provided the caterpillars are liberated far enough from the fields of young crops to be unable to return there.

EXPLANATION OF PLATE VII.

Figs. 1—8. *Agrotis ypsilon*, Rott.

Fig. 1. Egg much magnified.
" 2. Young caterpillar, magnified.
" 3. Older caterpillar, magnified.
" 4. The same in the natural resting attitude.
" 5. The second and third abdominal segments magnified.
" 6. Chrysalis, magnified.
" 7. Moth, wings expanded.
" 8. Moth, resting attitude.
" 9. *Agrotis flammatra*, Schiff.
" 10. *Euxoa segetum*, Schiff.
" 11. *Euxoa spinifera*, Hübn.

CO-OPERATIVE CREDIT AND THE CENTRAL BANK.

By H. R. CROSTHWAITE,

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So many people have already written on the subject of co-operative credit that I hesitate to swell the number. My only excuse is that I do so by invitation. Some two years ago, when the first attempts to instil the principles of co-operative credit amongst the people of the Central Provinces were made, it was supposed that any effort to establish societies would probably fail unless the money-lending classes were first conciliated. "In order to love mankind," said Helvetius, "one must not expect too much from them;" an endeavour to induce the leopard to change his spots was no plank in the platform of co-operative credit. It was recognized that in dealing with men of business instinct and tradition, no "dusty answer" would be sufficient to convince those whose "souls are hot for certainties" in the shape of principal and interest. It was of primary importance to convince these classes that the co-operative credit movement would benefit them as well as others. The tactics adopted were cautious and may be described in the words of Francis Bacon—"not to undertake things beyond the strength of Government, not to row against the stream, not to wait for occasions always, but sometimes to challenge and induce them." It was amongst the money-lending classes that the gospel of co-operative credit was first preached.

It was necessary to explain to the capitalist the meaning of co-operative credit and to show that rural societies afford scope for safe investment with a prospect of a reasonable return. In order to do this satisfactorily, it was not forgotten that there is

but one general rule of evidence—the best must be produced that the nature of the case will admit of. Recourse was had to practical demonstration. A few societies were started with capital raised partly by shares sold to members, and partly lent by Government or the Court of Wards. The rate of interest on loans to members was low—9 per cent.; members alone could borrow; after the provision of a reserve fund, profits were to be distributed *pro rata* to the shareholders.

The main objections taken to these societies were that they were not such societies as the Government of India contemplated when legislation was first undertaken, that they were mere profit-making machines run for the benefit of some of the non-borrowing members, and that neither Wolff nor Raffeisen would be able to trace in them any resemblance to the societies of which they were the founders. These criticisms were sound and fair; but the initial societies were formed as a stepping stone towards better things. As has already been pointed out, it was considered essential to enlist the sympathy of the non-borrowing classes. Accordingly in these first societies, borrowing and non-borrowing members were deliberately amalgamated in one body. "All confidence is dangerous unless it is complete," said La Bruyère; "there are few circumstances in which it is not best either to hide all or to tell all." It was clearly of great importance that the non-borrowing classes should have an opportunity of becoming acquainted *at first hand* with the working of societies having machinery bearing some resemblance at least to that of the rural societies which the later development of the Central Bank would finance.

These first societies are now flourishing in the Central Provinces and are fulfilling at least one function of Raffeisen Societies. They are succeeding in providing any man, whose character stands high enough with his fellows to procure him election as a member, with money to carry on his cultivation at a reasonable rate of interest. The management of the affairs of a society is vested in a committee elected by the members themselves. The greatest objection to which these societies stand open at present is that they are more or less dependent on a certain amount of official

supervision, but it would be wholly erroneous to say that the societies were started "by Government Order." The fact is that when the cause of co-operative credit was first pleaded with the people as they sat round the writer's camp fire, they themselves stipulated for a certain amount of aid and supervision at the outset. Accordingly when the societies formed in the Hoshangabad District first started practical work, being still but infants, their steps were very carefully guided. The various committees received no orders; they were not peremptorily told that they must do this or must not do that; the chaprassis at the door had strict injunctions to usher at once the "Secretary Sahibs" and the "President Sahibs" into the presence, and many were the occasions on which they came to seek advice and assistance. It must be confessed that at first many of the people received the idea of co-operative credit *nec amore et sine odio.* But dawning perception has awakened a spirit of real interest, and these societies stand as successful object-lessons, if not of the ideal form of co-operative credit, at least of the fact that joint responsibility and admission to membership by election produce a body of honest borrowers.

It is a common cry that there is no public spirit amongst the people of India. If one were to ask amongst which class there is the least desire for the welfare of others, the answer would probably be "amongst the money-lenders." But it is a fact that the Banias of the Central Provinces, just as the Jews of other countries, are the class whose application to business is greatest, and whose success is most proverbial. We know how in the history of the world the Jew has for centuries been cast for the rôle of the oppressed; we know the present position of the Jew in Russia and Germany. It would be too much to say that the Bania is the object of universal animosity, but it cannot be disputed that he is often regarded with the eye of suspicion, and generally of jealousy. Like Shylock, he wants his pound of flesh. In common with the physician his services are only sought by those whose necessities demand them, and in common with the physician the price charged for the benefit bestowed is frequently condemned as extortionate. While, however, the services of the doctor frequently inspire feel-

ings of gratitude, the usurer has in all countries and in all ages been unpopular. It was Tocqueville who said that "he who despises mankind will never get the best out of either others or himself." The saying is one which is worth the consideration of the worker in the cause of co-operative credit. "If by the term public spirit," wrote Major-General Sir W. H. Sleeman, "be meant a disposition on the part of individuals to sacrifice their own enjoyments or their own means of enjoyment for the common good, there is perhaps no people in the world among whom it abounds so much as among the people of India. To live in the grateful recollections of their countrymen for benefits conferred upon them in great works of ornament or utility is the study of every Hindu of rank and property. Such works tend in his opinion not only to spread and perpetuate his name in this world, but through the good wishes and prayers of those who are benefited by them to secure the favour of the Deity in the next."

Next, then, to pointing out to the money-lending classes that to invest money in co-operative credit societies was worth their while, it was expedient to lay stress on the fact that the movement was a philanthrophic one, designed to ameliorate the condition of the tillers of the soil. To aid in such a movement is to acquire merit. The inducement is one that tempts civilized men of nearly every race and creed. The argument gathered strength when the results of the money-lending transactions of some of the leading Banias were revealed. It fell to the lot of the writer to assess the income tax and to hear the usual pleas for a decrease in the burden of taxation on the score of decrease in income. The task presented many opportunities to one desirous of ascertaining what proportion of interest (at the usual "sawai" or 24 per cent. per annum rate) was actually realized. If anything definite could be arrived at, then the guide to the rate of interest that would attract capital would be invaluable. Once satisfy the money-lender that new ways of employing his money would bring him in as much interest as the old, and a great deal would be accomplished. No one will dispute that the methods which entail the employment of lawyers and pleaders, attendance at court and legal costs, mus

necessarily be very expensive. The law too is uncertain, and just claims are sometimes defeated. When, then, several money-lenders proved that the income derived by them from the capital sunk in small loans yielded a return of only 8 to 10 per cent., co-operative credit scored another notch. The contest became one between knowledge and tradition. It was pointed out to the money-lenders that rural societies were small affairs for small people only; that the scheme of operations did not include such folk as large landholders anxious to borrow a few thousand rupees for fireworks; that the old game of a man burdening his resources with the interest on large sums borrowed for ceremonial expenditure and then being unable to pay the interest in poor seasons, must continue to be played; that, in fact, no encroachments on the profitable portions of the money-lender's happy hunting ground were to be made. The writer recollects the keen interest with which the Banias heard of the enormous fortune left by the most notorious money-lender of recent years, the late Mr. Sam. Lewis, and of his methods; how Mr. Lewis never made small loans but confined his dealings entirely to advancing many thousands at a time on the security of very valuable property. In the end, many of the Banias were convinced that the creation of rural societies would afford them a safe means of investment without any of the expenses of collection attendant on traditional methods, that the net return would be as great, if not greater.

Had the writer stayed in the Hoshangabad District, his next step would have been to form Tahsil Central Banks to which rural societies would have applied for money. The last section of the Co-operative Credit Societies Act confers a very wide discretion as to registration. Nobody pretends that a Central Bank with capital subscribed by the leading men of the tahsil, managed on purely business principles, and existing solely for the purpose of lending money to rural societies, is itself a Co-operative Credit Society in any sense of the term. Yet it exists for the purpose of associating the best business talent available with the co-operative credit movement, and is intimately connected with the scheme for financing and testing the merits of the class of rural societies roughly

sketched in this article. The Central Bank should then be registered under the Act. Shareholders in the Central Bank can, of course, reside anywhere, but the committee should be chosen from shareholders resident within the tahsil. What is wanted is a committee with good local knowledge of all parts of the tahsil. It will not only control the internal affairs of the Central Bank, but will consider the applications of rural societies for loans and decide to what extent individual societies are *bankable*. The Central Bank is not only to be the source whence rural societies are to derive their capital, but a means of gauging the worth of newly-formed rural societies. It may be argued that too much power will be left in the hands of the Central Bank, that as "interest speaks all sorts of tongues and plays all sorts of parts, even the part of the disinterested," the central committee will be able to starve the rural societies, and thus kill the movement. To this no present answer can be given. The question is one of confidence, and time alone can prove whether that confidence has been misplaced or not. It is idle to apply closet logic to schemes of co-operative credit. The personal equation must always count for much. Let us be content to go to school with experience. "Englishmen," wrote Sir Henry Maine, "are wont to be content with the rough rule of success or failure as the test of right or wrong in national undertakings." Though rough, the rule is not a bad one when judging schemes of co-operative credit.

It may be suggested that the most convenient method of raising capital for the Central Bank is by guarantee and subsequent call for payment. This prevents the accumulation of idle money. It is from the Central Bank, then, that the rural societies are to obtain money. The district officer must form the rural societies as he finds opportunities when in camp. He must explain the advantages of co-operative credit to the villagers; he must aid in drawing up simple rules, the articles of association and the application for registration; and he must superintend matters until the rural society is launched as a body corporate. Once that is accomplished, the rural committee must look to the Central Bank for their funds. The Central Committee will enquire as to

whether the new society is bankable or not, and, should their enquiries be satisfactory, will grant the rural society a credit, a cheque book and a pass book. The cheques of the rural society will be cashed when presented, and interest will run from the date of disbursement only. A date must be fixed for the repayment of each sum disbursed, and default will mean suspension of further credit. Probably it will be found most convenient to settle accounts two months after each harvest. Government should not be asked for a rupee. The writer has not yet met a single man who urged that Government should aid with money in order to show that its purpose was earnest, without finding that the idea had been put into his head by an officer of Government. Directly the maker of such a request was invited to think for himself, he could discover no reason why Government should *not* be earnest.

These rural societies will be able to borrow at nine per cent. and lend to their members at twelve per cent. The small margin of three per cent. will provide all necessary working expenses and will in course of time furnish reserve and working capital. But no elaboration of the subject is required here. In attempting to solve the problems which confront us, let us steadfastly bear in mind that it is the first purpose of co-operative credit to provide the cultivator with capital at a reasonable rate of interest. The Government of India have laid down that the establishment of rural societies is to be our first care. Let us not then be too ready, as Mrs. Browning says,

> "to talk by aggregates
> And think by systems, and, being used to face
> Our evils in statistics, be inclined
> To cap them with unreal remedies
> Drawn out in haste."

In matters co-operative we must not advocate too strenuously the rigid application of the methods of another hemisphere. It should be possible to clothe the spirit of co-operative credit in an Indian garb without the usual official trimmings. Very possibly her attire will not be the latest confection from Utopia, but it can be, none the less, a practical working garb.

IMPROVEMENT OF THE SUGAR INDUSTRY OF MYSORE.

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Before trying to find ways and means of expanding our sugar industry, we must, of course, see whether there is any room for expansion, what the market is, and what grade or quality of sugar that market demands; for although a poor quality of sugar may be converted into a better one by refining, this method may not be the most economical, and to convert a high grade sugar into one of a lower grade should, of course, be out of the question, notwithstanding that this is done at times, if the standard of valuation adopted is that used in the sugar markets of the world.

India, once so noted for its sugar industry that sugar was known in England as Indian salt, has now dropped so far behind in the world's sugar supply that instead of exporting sugar for the use of other countries, she cannot now supply her own demands, but imports large and ever-increasing quantities of sugar. In 1894-95 the total imports of all classes of sugar, including molasses and confectionery, were a little over 168,000 tons. Ten years later (the last for which I have figures), these imports had more than doubled, being in round numbers 347,000 tons. Of this a very large proportion is classed as refined sugar, and the remainder is imported with the intention of refining it in India. All these imports (excepting the molasses which makes up about 5 per cent. of the total) may, therefore, be considered as reaching the consumer in a refined or at least a partially refined condition.

These large imports of sugar seem to prove that there is room for expansion of the sugar industry, if we can manufacture at a profit in India the quality of sugar now imported and for which

we pay in round numbers seven crores of rupees. But as there are no imports of jaggery or gur, and as the imports of the class of sugar resembling it are very small, it is evident that there is not much room for expansion if we confine our attentions to the production of jaggery as such. It may be that by reducing the cost of production or by putting a better quality on the market at a cheaper price, we probably may be able to recapture some of our home markets which are now in the hands of foreigners and are supplied by them with the poorer quality of partially refined sugar, but in order effectually to check these large imports, especially of the better quality of sugar, we must supply a quality equal to that now imported at the same or a lower price. The fact that the market for jaggery is very limited is illustrated by the great variations which occur in the price; with a slight over-production the price drops and drops heavily, and when there is a shortage, it rises enormously; low prices are sometimes only one-third the prices paid at other times. This great fluctuation has of course a demoralizing effect on the cultivators of sugarcane.

Some high grade sugars may be produced at a profit by making jaggery first and sending this to the refineries, as is being done now on a small scale, but the fact that these refineries have not been expanding at anything like the same pace as the imports indicate, I believe that they must be labouring under some disadvantage compared with the factories which supply the imported sugar. Much has been written about bounty-fed sugars, but the practical exclusion of these has not apparently checked the imports very materially. There is evidently something more at fault than any undue commercial advantages given to producers in other countries.

However, Indian refineries have been able to exist and have been able to use to some extent as raw material the jaggery produced from sugarcane grown in India. Thus some of the sugar produced in India is already successfully competing with the imported article, which is the best indication that, if we are able to improve on existing conditions, our industry will probably expand in direct proportion with the improvements introduced. A search for defects in our present system is, therefore, the first

step to take for the improvement of the sugar industry. An alternative method is to try and introduce the methods adopted in those countries now sending us their sugar, but if we remember that the conditions in India are not identical with those in other countries, that for example the sugarcane fields here are often small and scattered while in other countries they are large and compact, and that many enterprises started in this way have been failures, it is evident that it does not necessarily hold good that because methods have proved successful elsewhere, they will succeed in India. In places where the conditions appear favourable, and where there are comparatively large and compact areas of sugarcane lands, those who can command the capital may try with advantage the experiment of building large up-to-date sugar factories, but even in this case preliminary experiments should be made on a small scale to determine what the conditions are and what promise of success they give for the large enterprise. Besides, there are many places where the areas suitable for sugarcane are too small and scattered to admit of the use of large modern machinery, and yet sugarcane is now being grown with success in some of these places. These would receive very little advantage from the introduction of large factories, but might be greatly helped by the results of experiments carried out on a much smaller scale. These small or preliminary experiments appear to be not only useful but absolutely necessary for a systematic study of the sugar industry, and I propose to give a synopsis of some made in Mysore.

The sugarcane found in Mysore is generally of excellent quality, containing as a rule between 16 and 19 per cent. of cane sugar* and about half per cent. of glucose.† The percentage of fibre ‡ is

* *Cane sugar* is the substance we know as sugar ; ordinary granulated sugar, or loaf sugar, is almost pure cane sugar.

† *Glucose* is a sugar of simpler construction and of less value than cane sugar. It is not so sweet, more easily soluble and dissolves an equal quantity, or more, of cane sugar or prevents it from crystallizing. The bulk of the glucose and the sugar it holds in solution is lost in the molasses. The presence of glucose in jaggery tends to make the jaggery 'sweat' and reduces its keeping quality.

‡ *Fibre* is a term I have used in place of the technical term, "Mark," because it approaches the meaning of that term and is better understood. By it is meant the frame work of the sugarcane, the refuse cane from which every bit of juice has been extracted.

low, generally between 8 and 10. Occasionally the cane sugar content rises to over $21\frac{1}{2}$ per cent., the glucose drops below $\frac{1}{4}$ per cent., and the fibre to nearly 7 per cent. This is a quality of cane, so far as I know, seldom if ever surpassed elsewhere. The yield of cane is also not small, running up to 30 tons or more per acre when well cultivated. This is, however, very far short of what is produced, for example, on the Hawaiian Islands where over 10 tons of sugar per acre have been produced on a 100-acre field with cane much inferior in quality to our own. The average yield of cane per acre in Mysore is probably much below the figure given and, judging by the indications available, it can be materially increased. Peru, not yet noted for its sugar industry, produces a sugarcane almost as rich as ours, the chief difference being that it has more fibre, and yet on one large estate the yield of sugar per acre has been increased from an average of nearly two tons to an average of almost five tons in a period of six years. Whether a similar increase is possible in Mysore, future experiments may show, but little work has been done so far in this direction.

The old wooden sugarcane mill formerly used in Mysore has, for practical purposes, been entirely replaced by small three-roller iron mills of local manufacture, worked by bullock-power. This has made an enormous difference in the amount of juice extracted from the cane, judging by the appearance of the begasse. Still these little three-roller iron mills can be further improved. When worked to about their utmost efficiency, the juice left in the crushed cane is still very considerable. In a fairly long series of experiments it varied from 20·2 to 38·7 per cent. of the total quantity of juice originally in the cane, the average of these experiments showing that 26·1 per cent. of juice was left in the refuse, or in other words that out of every 100 lbs. of sugar originally contained in the cane, 26 lbs. are lost. These experiments showed that for every ton of cane milled a little over 105 lbs. of sugar were left in the refuse when the work was very carefully done, and with the ordinary milling much more would be lost. Of course no mill, however powerful, will be able to save all this sugar; some very large nine-roller mills have taken out all but 8

per cent. of the juice, but such mills would be much too expensive and much too large for use in most places in India. The largest mill in Mysore at the present time is one with three rollers, 18 inches long and 12 inches in diameter, which is driven by a $6\frac{1}{2}$ horse-power engine. When set as ordinarily used, the loss of juice in this mill was $19\frac{3}{4}$ per cent. of that in the cane, and when set in this way, the mill crushed very nearly 1 ton of cane per hour. When this mill was set tight, 18·2 per cent. of the total juice was left in the refuse ; or, in other words, nearly one-third of the juice lost when using the ordinary mill was saved by using this larger mill. Taking these figures as approximately correct (and they represent the average of several closely agreeing results), and assuming the crop of cane to be 20 tons per acre, this would represent a saving over the ordinary mill of between 800 and 900 lbs. of sugar per acre or over 1,000 lbs. of jaggery or gur. With average prices this would imply a saving of Rs. 50 or more per acre on this one aspect of the question. In districts where the fibre in the cane is more than in Mysore, the saving would be proportionately greater, because the more fibre in the cane, the larger the percentage of juice retained in the refuse, and the larger, the total quantity the larger, of course, the third of that quantity which would be saved by the larger mill.

After the juice has been milled, there are heavy losses which can be avoided without any additional outlay for machinery. These are not as apparent when the juice is boiled to jaggery which is intended for direct consumption, as they are when the juice is used directly for making refined sugar. Some of these losses are due to the decomposition of the cane sugar into glucose either by fermentation or by free acids left in the underlimed juice. Each pound of sugar thus decomposed implies the loss of at least a second pound of sugar, which the glucose formed from the first pound keeps in solution. In sugar-making both these pounds find their way into the molasses, from which not even a part of them can be separated by ordinary methods. If the juice in which this decomposition has taken place is boiled into jaggery, both these pounds are of course retained in the solid mass to begin

with, provided always this decomposition has not gone beyond a certain point, but more or less of it will be lost in time by sweating if the jaggery is stored.

Heavy losses due to fermentation are not so frequently met with as those due to underliming. In one instance, however, over ten per cent. of the total sugar in the juice was decomposed by fermentation, which implies a total loss of over 20 per cent. of the sugar in the juice from this cause if the juice is converted into sugar. This particular sample of juice was milled from a thin hard cane (locally known as "Chini") in the middle of a hot day. Doubtlessly the earthenware chatty used to store the juice contained the ferment in its pores, which inoculated the juice, the heat of the day favouring their rapid growth in the juice. The remedy lies of course in using nothing but iron or copper vessels, keeping them as clean as possible, and boiling the juice immediately after it is milled. Juice run into clean vessels may, however, sometimes be kept a considerable length of time without decomposition. In one set of experiments the juice kept practically unchanged for nine hours, and some of it was kept for over thirteen hours without decomposition. Other samples had, however, undergone considerable decomposition in six hours time. The slight alkalinity caused by liming these samples at once had no marked effect in preserving them. Although this indicates that when perfect cleanliness is observed some time lapses before any considerable decomposition takes place, it is well not to count on this, but to boil the juice as quickly as possible, for boiling kills the ferment causing this decomposition.

The loss caused in Mysore from underliming is probably much more than is generally realised. The average of one set of experiments showed a loss from this cause of $13\frac{1}{2}$ per cent. of the total sugar in the juice. On an average a shade less than half the quantity of lime required to neutralize all the acid was used in these experiments. These losses represent those actually occurring in everyday practice, as the analyses were made in the cultivators' fields, and all the samples except those required to check the results were prepared by jaggery boilers in the ordinary course of their work.

There is of course some decomposition of sugar in properly limed samples when the juice is boiled down in open pans over an open fire, but when the percentage of glucose originally in the juice was small, this decomposition was small also, much smaller than is generally supposed. In some samples of juice which contained a comparatively large percentage of glucose to begin with, the decomposition of cane sugar was quite considerable when the juice was being boiled down in an open pan, even if it was sufficiently limed. This is a point requiring much further investigation.

Comparatively little difficulty is experienced in inducing the more advanced ryots to see the desirability of preventing fermentation, but it is not so easy to induce them to prevent loss due to underliming, because they fear that by heavier liming a jaggery of darker colour will be produced than would otherwise be the case. Now jaggery is almost invariably produced with the expectation that it will be consumed as such, and as a light colour is probably by far the most important point in judging such jaggeries, it is quite reasonable that they should strive to produce a light-coloured jaggery. Unless a sufficient quantity of lime has been added to the juice to prevent either a piece of blue litmus paper or a piece of red litmus paper from changing colour when dipped into the juice (which indicates that the juice is neutral in reaction), or when a properly prepared piece of red litmus paper just changes to a faint bluish tinge (which indicates a slightly alkaline reaction), the more lime added to the juice, the darker the resulting jaggery becomes. But when enough lime has been added to make the juice either neutral or slightly alkaline in reaction, the jaggery boiled from it is much lighter in colour than it would have been if only three-fourths or even half of that quantity had been added. At least, this result has been obtained in a large number of experiments made with sugarcane grown on a dark red soil in Bangalore, and it is highly probable that these experiments have a general application. If this is the case, it would be a great step in advance always to use litmus paper, no matter whether jaggery to be consumed as such or some high grade sugar is to be produced. This is a point

which cannot be too strongly emphasised, for although there are other ways of testing the juice to see if sufficient lime has been added, these are, I fear, either not sufficiently accurate or too complicated to be used by the cultivators.

Thus far jaggery only has been considered as a raw material out of which to make refined sugar, because that is the method at present employed in Mysore and Southern India. But with a little outlay on machinery, a much better raw material than this can be prepared in the form of raw sugar. I say raw sugar because it is not white, although it can easily be made of better quality than some of that now imported under the head of refined sugar. With only a centrifugal in addition to the appliances generally used by the cultivators for jaggery boiling, a sugar having 98½ per cent. of cane sugar and less than ½ per cent. of glucose has been prepared. In colour it resembled much more closely a white sugar than the lowest grades of imported sugar classed as refined. A quantity of juice which would have given 100 lbs. of jaggery gave 73·3 lbs. of this sugar and in addition 5·2 lbs. of sugar of a somewhat inferior quality. The latter was produced by reboiling the molasses, and is technically known as second sugar. A sugar of this quality would, as said before, be an excellent material for refining purposes. In fact, it is of better quality than it need be for that purpose, and could, doubtless, directly replace some of the sugar now imported under the heading of refined sugar. This particular lot of sugar was washed in the centrifugal with nearly 7½ per cent. of water. The object of this is to remove, as far as possible, all the molasses adhering to the outside of the individual crystals of sugar. This thin film of molasses contains a large part of the impurities remaining in the sugar, including the colouring matter, and by removing as much as possible of this film the colour is materially improved. On an average 4·12 per cent. of water was used here in the experiments in which sugars were washed in the centrifugal, and this removed a little over 39 per cent. of the colouring matter and over 27 per cent. of the glucose contained in the unwashed sugars. But as some cane sugar is also removed with these impurities, washing in the centrifugal is generally to be recommended

only when it is desired to prepare as high a quality of sugar as possible for direct consumption.

Some of the chief advantages of removing the molasses from the sugar, instead of boiling the juice of the sugarcane down to jaggery, are that (*a*) a comparatively high grade sugar having a comparatively light colour is obtained : (*b*) if intended for refining, about 14 per cent. or a little more of the total weight of the jaggery, which has been removed in the form of molasses, does not need to be passed through the refinery : (*c*) the char filters which remove the colouring matter will last very much longer because there is comparatively little colouring matter to remove ; and (*d*) the raw sugar keeps better in store than the jaggery, and that portion of molasses which would be lost by "sweating" is saved and does not foul the store room.

The results which have been obtained here up to the present are so eminently satisfactory that it appears highly desirable to go further and remove if possible all the precipitates produced by the addition of lime to the juice. In these experiments only a part, although a very large part, of the scum which rose to the top on boiling the limed juice has been removed. These scums were filtered through a piece of "long cloth," and when freed from all the juice which could be removed in that way, amounted on an average to 1·82 oz. for every 100 lbs. of juice employed or 0·113 per cent. of the total weight of the juice.

I may now sum up my conclusions. As there are large importations of refined sugar into India, it is natural to assume that a large and growing market exists for these sugars, and as this quality of sugar is already produced in India to a limited extent, it appears reasonable to suppose that this market can be captured by sugars produced in India, if present methods can be sufficiently improved. The Indian sugarcane, at least that grown in Mysore, is of excellent quality, and labour is relatively very cheap, less than one-seventh of what it is in Louisiana where large quantities of sugar are produced notwithstanding that the quality of cane is very much inferior to ours. In the present method of manufacture heavy losses occur. The average of a number of experiments

indicates that more than one-fourth of the total quantity of the juice is left in the refuse, that with a larger mill one-third of this loss can be saved (still larger mills would probably save two-thirds), that as much as twenty per cent. of the total sugar in the juice is sometimes lost by fermentation, and that as a rule over 13 per cent. of the total juice is lost by underliming. On the whole, the losses amount to at least one pound out of every five, that is, for every four pounds of sugar now obtained at least five could be got by stopping these heavy leaks, and probably the quantity of cane now giving three pounds of white sugar would as a rule give four pounds of such sugar when these losses are prevented.

This would probably be quite sufficient to transform a crippled industry into a flourishing one. But there are further savings which can be introduced by manufacturing directly from the cane a sugar of much higher grade than is now being done when making jaggery. Part of this sugar without being refined could directly replace a portion, and possibly a very large portion, of the sugar now imported, and the rest could be sent to the refinery for conversion into the very highest grade of sugar, being thus transformed with a better outturn and at much less expense than an equal weight of jaggery.

ORANGE CULTIVATION IN THE CENTRAL PROVINCES.

By R. S. Joshi, Rai Bahadur, L. Ag.,

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The chief centres of orange cultivation in the Central Provinces are the southern districts of Nagpur and Wardha. The black soil of this tract contains a larger proportion of lime than that present in the black soils found in the north of the Provinces. This lime occurs both in the finest state of distribution in the soil and in the form of calcareous nodules (*kankar*). The sites selected for orange cultivation all have a subsoil of gravel (*murram*), also containing lime, which gives good drainage. The average annual rainfall of 47 inches is suited to orange cultivation in land with good drainage, not being too heavy during the monsoon and giving a good supply of water in the wells for irrigation during the rest of the year. The subsoil water varies in depth from 20 to 35 feet and is raised from the wells by bullock-power with the ordinary leather bucket. In years of drought the wells run short, when some plantations suffer heavy losses ; the damage to orange cultivation from the drought of 1900 has not yet been made good, but of recent years plantations are again increasing. The temperature, which ranges from a maximum of 85°F. to a minimum of 54°F. in the cold season, and 108°—93° in the hot season, seems admirably suited to the orange, the fruit ripening to perfection with a good flavour. The Nagpur orange has a reputation second to none.

Tradition relates that the orange was first introduced into Nagpur by the Bhonsla Rajah, Raghoji the Second, about the end of the eighteenth century, from Aurangabad and Seetahole. There is only one variety, locally named *santra*. All the plants are propagated by budding, the growth of plants from orange seeds not being practised. The stock generally used is the sweet lime (*mitha nimbu*),

PLATE VIII.

A. J. I.

A Nagpur Orange Garden.

but the common citron (*zamburi*) is also very often utilized. Buds of the orange grafted on the latter stock produce trees which yield fruits with a very loose skin, whilst those on the former stock have a more closely adhering jacket, showing that the stock has a distinct influence on the bud. The loose jacket oranges are preferred for local consumption, but are not so good for export, as they do not stand carriage well. Trees raised from the citron stock come into bearing more quickly and have a somewhat longer life, but the fruit from the sweet lime stock is sweeter and has a thinner skin.

The seeds of the sweet lime or citron are taken from the ripe fruits during the months of November to January and are immediately sown whilst quite fresh in pots or baskets filled with equal parts of leaf-mould and black soil. The seeds should be covered with about an inch of this mixture, and should only be given light watering just sufficient to keep the earth moist. The seeds germinate in about fifteen days, and seedlings are allowed to remain in the baskets until they grow 3 to 4 inches high, which occurs with the commencement of the rains in the following June.

The seedlings are then transplanted about 4 inches apart in a raised seed bed, manured with well-rotted cowdung, and are regularly watered. In the following October, they are again transplanted about one foot apart in richly manured and thoroughly drained nursery plots. Irrigation is given once or twice a week according to the state of the soil. The plots are again heavily manured, the manure being worked into the soil with a hoe. In about two years from the time of sowing the seed, the plants become about two feet high and are ready for budding. This operation is carried on from November to January, when the sap is flowing upwards; the practical test employed by the gardener is that the bark must not adhere closely to the stock and the bud must come freely from the orange tree. When the bud commences to grow freely, the main shoot of the stock is severed. The budded plants are thus allowed to grow until the following August, when they are ready to plant out in the permanent orchard. Young plants intended for transport to a distance are treated separately. They

are dug out with as many roots as possible, the roots being twisted round the plant, which is again put back in its place. The object of this practice is to secure that the plants can be dug out again without much disturbance of the main roots.

The selection of a site for a permanent orange garden is a matter of some difficulty, in which the most experienced gardener will sometimes make a mistake. Two plots may appear to be exactly similar, but one will make a good garden whilst the other will never succeed. The site should be open, high-lying and thoroughly drained; the soil should be rich, friable, black soil, but not too deep, and there must be a good open subsoil of gravel. Pits, measuring 3 feet square and 4 feet deep, are dug in straight lines at a distance of 12 to 15 feet apart. These are filled at the commencement of the rains with a mixture of equal parts of earth and old cowdung. The plants are put out towards the middle or end of the rains, and are irrigated twice a week for the first month, if there is no rain. Afterwards, during the dry cold season, they are irrigated every nine to twelve days, and in the following hot season the number of waterings is increased to one every 4 to 6 days. Mature trees are not irrigated quite so frequently. The soil round the plants should frequently be stirred with a hoe. At the commencement of the next rains, the land should be ploughed and the earth around the plants should be dug up, a basketful of old cattle manure being mixed with it. It is the practice of some Nagpur gardeners to grow catch garden crops in the intervening spaces, but this is not done by the best cultivators. The soil should be frequently stirred with the bullock hoe (*bakkhar*) throughout the open season, and as often as possible during the rains. A ploughing should also be given at the end of the rains. Suckers are constantly thrown out from the stock and must be nipped off so as not to check growth from the bud. Special attention should be given to this matter when such shoots appear on full-grown trees as well as on the young plants.

With careful cultivation, weeding and irrigation, the young plants commence to bear fruits in their third year from the time of planting (six years from the time of sowing seed), and in five

years from the time of planting the trees will give a full crop, which will continue for some 8 to 10 years, after which the yield gradually lessens. It is advisable at this stage to start a new plantation in the intervening spaces, and as soon as these new plants are three to four years of age, the old trees can be cut out. The orange tree attains an average height of about 16 feet, with a maximum of about 20 feet; the girth of the trunk is about 30 inches, and the circumference of the crown about 40 feet. The average number of fruits borne by a tree in full bearing may be estimated at about 1,000, but sufficient care is not given to thinning out the crop.

The orange tree blossoms twice a year, once in June-July and again in February-March, the fruits of the former ripening from February onwards, and the latter in December-January. The wise gardener never allows the same tree to bear both crops, as this weakens it and shortens its life. In order to regulate the crop, he adopts the following practice. About the end of May some fifteen to twenty days before the commencement of the rains, the selected orange trees should have a trench dug around them, about one foot deep and two feet broad, leaving a circle of two feet in diameter round the stem. This operation of exposing the roots should never be done to a tree that has not attained the age of five years. In thus exposing the roots, care should be taken not to injure the large roots, but only to prune off the small fibrous roots. The roots should thus be left open until the leaves begin to drop off with the cessation of the flow of sap.

The trench should then be refilled with a mixture of three parts manure and one part fresh earth taken from the intervening spaces. Cowdung or poudrette is most commonly applied, but gardeners also like to use the refuse of lime kilns, old mortar and ashes. If the rains do not arrive immediately on the completion of this operation, copious irrigation should be given every fourth day. When the rain comes, the irrigation channels should be filled up and no water allowed to stagnate near the stem. In about a fortnight's time, the trees thus treated will produce new leaves and blossoms, which is called the *Mrig-bahar*, because this is the time of the *Mrig Nakshatra*. The fruits take about

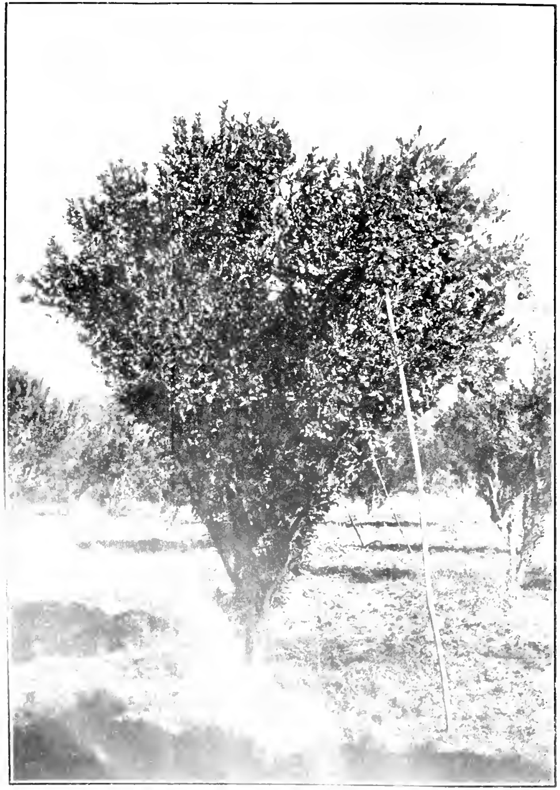
nine months to ripen, and are preferred to those of the alternative crop, which is obtained by a similar treatment of the other trees in January. This gives the *Ambia-bahar*, so called because the blossom comes in February at the same time as the blossom of the *amb* or mango tree. The practice of pruning the branches is unknown to the Nagpur gardener, but the tree can be much benefited by light pruning of withered and weak branches in order to improve the shape and give sufficient space and air for the development of the fruit.

The ripe fruits can be kept on the tree for nearly two months, but they gradually lose their pleasant flavour and become insipid. If it is desired to keep the ripe fruit on the tree, great attention must be paid to the irrigation, for either too much or too little water will cause the fruits to drop; about once a week is the usual period. The bulk of the crop is consumed locally, but there is a fair export trade, principally with Bombay and Calcutta, the quantity so exported being about 600 tons a year. The fruit is very carelessly packed in rough bamboo baskets, the only protection being a few plantain leaves at the sides. At least one attempt was made to export oranges to England, each fruit being rolled in paper and then packed in a wooden box with air holes, but this was not successful. The price at Nagpur is about Rs. 3 per hundred, so that the fruit is by no means cheap even at the place of production.

The most serious disease of the Nagpur orange tree is caused by a fungus, which results first in a withering of the tips of the branches, the rot gradually extending down the branches until the whole tree is worthless. A bad example is shown in Plate IX. This is not one of the known diseases to which the tree is liable elsewhere, and has not yet been studied. At present the only remedy that can be suggested is to cut out and burn the infected portions of the branches.

The orange also suffers from the attacks of several insects, the most harmful of which is a borer beetle of the *Cerambicidæ* family. The female generally lays its eggs on the branch or stem of the plant ; as soon as the larva is hatched, it eats its way through

PLATE IX.



A HEALTHY ORANGE TREE.

A. J. I.

A DISEASED ORANGE TREE.

the bark into the wood. This attack on the bark and sap of the tree causes the branch to wither and may kill the tree. Its attack can generally be discovered by the presence of sawdust at the mouth of the hole. The easiest remedy is to cut off and burn the branch, but if the main stem is attacked, the best thing is to try and kill the insect by inserting a wire into the hole or to syringe a mixture of kerosene oil and water into the hole.

The larvæ of *Papilio demolues* have been found to feed on orange leaves, the injury from these caterpillars sometimes being considerable, inasmuch as the foliage upon which the fruit development depends is destroyed. The common weed, locally called *Bawachi* (*Psorolia coralifolia*), is a favourite host plant for this insect, so that it should not be allowed to grow round an orange garden. The best remedy is to spray the trees with lead arseniate; the caterpillars can also be picked off by hand.

Another insect pest sometimes causes the loss of much fruit. A very minute hole is first observed on the rind of the fruit, which gradually forms a circle of rotten rind, about half an inch in diameter, when the fruit falls. In some years nearly all the fruits of a tree will thus drop in August and September. If the pulp of the fallen fruit is examined, no insect can be found. The insect causing this injury has not yet been properly investigated, but is probably the moth of *Ophideres*. One cultivator in Nagpur has overcome this pest by covering the trees with mosquito netting, thus saving an excellent crop.

Scale insects and mealy wings sometimes cause damage by sucking the sap. Spraying with kerosene oil emulsion is the best remedy.

NOTES.

APPLE CULTIVATION IN INDIA:—The parts of India where apples are grown on any scale are the Himalayas, Punjab, Sindh, United Provinces, Central India and the Deccan. "In India at the present day, it is described as 'apparently wild' in the North-West Himalayas, ascending to 9,000 feet, and to 11,400 feet in Tibet. Dr. Watt is, however, disinclined to admit any of the apples as indigenous: the tree nowhere occurs in the wild profusion of, for example, the wild pear, and may certainly in most cases be no more than spontaneous from early cultivation."—(*Dictionary of the Economic Products of India.*)

An account of fruit culture in the North-West Himalayas is given in Agricultural Ledger No. 15 of 1894, in which, however, some of the race names are said to be incorrect. This may be supplemented by the following information, which has been courteously supplied by the Reporter on Economic Products, and is largely given in his own words.

The so-called indigenous apple of the North-Western Frontier is said to have a large sale in Kabul. It is grown in orchards in Afghanistan from seed, not grafted. Its fruit is rather small; one kind is sweet and palatable, while another is sour. Some of this fruit comes down to Peshawar. In Kashmir are races of apple called *Anbru* (ripens October and keeps), *Kuddu sari* (ripens early and will not keep), and *Trel* (ripens early and will not keep). In Ladakh several kinds of apples are grown, some grafted but mostly not. They extend along the Himalayas to Nepal, are grown at Lhassa (Tibet), and apparently in China. Some few are found in the Punjab plains under the hills.

European apples have been grown in India for a long time. So long ago as 1837, the race 'Non-pareil' fruited at Hyderabad

(Deccan); at the same time apples were grown to fruit in Tirhut (Behar), a little later in Chota Nagpur (Bengal) something like a Russet, and something like the 'June-eating' at Ferozpur. Several were grown in the Deccan at Ahmednagar, Bangalore and elsewhere, together with trees of the Afghan or Persian races. Firminger gives the names of the races grown at Bangalore as Ribston Pippin, Worcester Pearmain, Peasgood's Nonsuch, Lane's Prince Albert, Kentish Fill-basket, Dutch Cooling, Cox's Orange Pippin. They uniformly failed in Calcutta.

The apple-growing of Kulu is more recent, but has prospered greatly, and the exports to the plains yearly increase. In addition to the export of fresh fruit, there is an apple-drying establishment at Bajaura. An experiment at cider-making in Kashmir some ten years ago failed. The best Kulu apples hardly come into the Calcutta and Bombay markets, but some quantity of a somewhat inferior quality are sold along with imported Australian apples.

The apple-growers of Kulu are in the greatest confusion regarding their races of apples. Just as the English apples taken to America did not remain true to their type, so the English and American apples have departed from type in Kulu. The story of the change in America is instructive and is well told by L. H. Bailey:—

"In the beginning of the colonization of this country, for example, all the varieties of apples were of European origin. But in 1817 over 60 per cent. of the apples recommended for cultivation here were of American origin, that is, American-grown seedlings from the original stock. At the present time fully 90 per cent. of the popular apples of the Atlantic States are American productions. The Northern States of the Mississippi Valley, to which most of our Eastern apples are not adapted, are now witnessing a similar transformation in the adaptation and modification of the varieties introduced from the East and from Russia. The newly-introduced Japanese plums are conceded to be great acquisitions to our fruit-growing, but no doubt the best results are yet to come with the origination of domestic varieties of them. So there is an irresistible tendency towards a divergence of forms in different continental or geographical regions, and much of the inevitable result is no doubt

chargeable to climatic environment.'' It is necessary to do for India the same selection process as has been done in the United States.

The greatest attempts at establishing English apples in India have naturally been made in the Punjab and North-West Himalayas. The Lahore Agri-Horticultural Gardens alone have distributed some quantities of budded trees, but Lahore is outside the region where apples flourish. The trials in the North-West Himalayas are described in Agricultural Ledger No. 15 of 1894. In the United Provinces the Saharanpur Gardens have done a good deal towards distributing apple trees. It would not seem itself to be suited to the apple, but trees that would not fruit satisfactorily there are grown for sending to higher elevations. Cox's Orange Pippin is said to have done well. Kumaun orchards are referred to in the Agricultural Ledger.

In Sikkim at Gantok, excellent apples are grown, and a few are raised at Darjeeling. Experimental apple trees have grown at Hazaribagh and Ranchi, but fruited grudgingly. In the Khasi Hills (Assam) apples are said to grow well, and there is a wild stock upon which they can be grafted.

In the Shan States (Burma) considerable experiments with numerous varieties have been made. In the early years great difficulties were experienced in making successful grafts, and it was then discovered that the indigenous stock was not the true wild apple but *Docynia indica*, an allied but distinct species. As the Docynia grew so luxuriantly, the efforts to graft on it were continued with ultimate success. It was found that scions taken from apple trees raised on the Docynia stock succeeded better on the Docynia stock than scions taken from imported stock. The indigenous *Pyrus pashia* has also been successfully utilized as a stock. The latest report (1905-06) states that the kitchen varieties, such as Lord Suffield, Dumelow's Seedling, Northern Greening and Cellini Pippin are in full fruit, but that the dessert kinds are shy in bearing, Cox's Orange Pippin being the best. At Maymyo and Mitkyina (Burma), similar but less extensive experiments are in progress.

In Western India, Sindh produces fairly good apples. In the hills of Southern India, apples thrive, especially in the Nilgiri and Shevaroi Hills. Coonoor exports apples to the plains, but its orchards were more extensive formerly than they are now, aphis having killed a lot of trees. In Mysore, experiments are in progress at Bangalore.

In all parts where the apple has been grown, there is something upon which it can be grafted, but in many cases it remains to be seen whether it is really suitable. The principal requirement in the stock to a graft is a good root system, but there does not seem to be any available information upon the root systems of the wild crabs, pears and the like, used as stock.—(F. G. Sly.)

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The Ceylon Rubber Exhibition:—The leading events on the 17th September, 1906, were two lectures—one on rubber cultivation by Mr. Herbert Wright, the author of what is now the standard work upon *Hevea*, and the other on cotton as a catch-crop among rubber, by Dr. T. C. Willis, the Director of the Royal Botanic Gardens, Ceylon.

Before Mr. Wright's lecture commenced, we were enabled under the guidance of Mr. James Ryan to go round the more important exhibits and see in advance what form the various questions for discussion were likely to assume. A most interesting point in this preliminary view was the marked difference in character between two samples of Straits and of Ceylon plantation Para. The types from both quarters were beautiful in appearance (which I regret to say was not the case with the majority of our Indian exhibits), the samples of block and sheet rubber being clear and apparently pure throughout, and the crepe and scrap from the Straits making decidedly a better show than Ceylon, the advantage, however, being with the latter in the various biscuit forms. But this was merely the superficial view. Tested for resiliency and for firmness, the Straits staff could not compare with that of the Island. And the remarkable point was that this seemed to hold good of the acid-coagulated samples as well as with those coagulated without chemicals, and of the smoke-cured and unsmoked alike.

Having regard to the fact that the Straits and the Federated Malay States possess a climate and a rainfall more nearly approaching those of the Amazon Valley than anything to be found either in India or Ceylon, the almost inevitable conclusion was that the superiority of the latter was due to climatic causes, soils being practically equal. This at least was Mr. Ryan's view, and it was concurred in by most of the practical men present in his party. The enormous and the continuous rainfall of the Straits, so far from being the advantage it was hitherto believed to be, merely imported into eastern planting conditions, one of the peculiarities of the Amazon wild rubber—an excessive fluidity in latex, requiring special measures to counteract its ill-effects. Further confirmation of this theory was to be found in the evidence afforded by the very remarkable exhibits of Para. rubber grown at quite unusua lelevations and in a much scantier rainfall than that of either Para. or the Straits; for instance, Mr. W. T. Bird's sample grown on Wakwari Estate, Rangalla, Ceylon, at an elevation of 2,500—2,700 feet, and Mr. A. G. Nicholson's, grown on Hawthorne Estate, Shevaroys (Madras Presidency), at a much greater elevation (3,500 feet) and under a far lighter rainfall (45 inches) than the average of the Belgaum, Ratnagiri or Canara districts of Bombay. These were without exception excellent types of biscuit rubber. Not that others equally satisfactory were wanting among the Ceylon exhibits, but the light they threw upon the question of adaptability of *Hevea brasiliensis* to conditions most diverse from those of its natural habitat was very vivid. Many settled convictions on this matter will require reconsideration.

Another surprise presented itself in the excellent quality of nearly all the Ceara rubber samples. Here, again, the Wakwari Estate exhibited what to my mind was the finest piece of rubber in the whole show. If Ceara can only be made to pay its cost of production and extraction, with a reasonable margin of profit, it will prove a formidable rival to Para. The displaycof Castilloa was decidedly poor, and Rambong (*Ficus elastica*) not much better, a somewhat instructive sample of the latex of this species from Singapore being shown in an open box, three years old, and

yet as sticky as birdlime to this day. One can guess at the story of how that sample was gathered; a careless coolie left to his own devices supplementing the yield of a single *Ficus elastica* tree with the latex of the nearest *Pipal* or *Banyan*.

About 9-30 A.M., H. E. the Governor took his seat in the Lecture Hall, and Mr. Wright addressed the meeting. His opening remarks dealt with one or two unsettled questions affecting the future of Para. rubber-planting. Have we obtained in Ceylon the very best species? And have we taken due account of the risks of contagious plant disease? The first question Mr. Wright appeared to regard as practically answering itself, and one which might safely be ignored, but not so the second. If we had not actually secured the most valuable species of *Hevea* or variety of *Hevea brasiliensis*, we at least possessed a rubber tree giving us quite 90 per cent. of pure caoutchouc in its crude product, and it was well seconded by Ceara and Castilloa, which could be reckoned upon to give from 76 per cent. to 90 per cent. None of these sources should be neglected, but it was sound, having regard to the great hardiness of *Hevea* and its resistance to severe tapping, to plant it wherever it could be grown, in preference to, but not in exclusion of, the others.

The lecturer then alluded to the Landolphias and other rubber-vines or shrubs (chiefly African) and, in connection with the second question of dangerous infection from plant to plant of the same species, he suggested their inter-crop cultivation as a safeguard, as well as for what could be got out of their bark, branches and leaves. It may be mentioned that at this exhibition Messrs. Brown and Davidson, Mechanical Engineers, Colombo, had a stall containing among other things a couple of machines with oil-motor, for washing out and converting into very passable though not high-class scrap or crepe rubber the most unpromising lots of dead wood, bark and stem. Of this, ocular demonstration was given after the lecture, half an hour's work being sufficient to produce from a zinc bucketful of filthy-looking sweepings a strip of crepe rubber quite good enough to pass muster at anything from 1*s.* to 1*s.* 6*d.* a pound.

The lecturer then explained that the danger of over-production might not be so remote as planters thought. During the past year, 138,000 trees of Para. rubber in Ceylon had yielded 189,000 lbs. (84 tons) of rubber or approximately $1\frac{1}{2}$ lbs. per tree. Assuming an average density of 150 trees per acre, this represented an existing area under cultivation of 920 acres, and a yield of a ton of marketable rubber for every 10 acres. It might be taken, having regard to the comparative purity of plantation rubber, that 48,000 tons of the latter were equivalent to 60,000 tons of wild rubber—the world's present estimated demand. Let us suppose that the figures of consumption within the next five years double themselves, so as to amount to 96,000 or in round numbers 100,000 tons of plantation rubber per annum. The area required to produce that quantity at the rate of 10 acres a ton would only be 1,000,000 acres. We shall probably, the lecturer thought, have quite that acreage under rubber by 1910-1912 in the British possessions in the East alone. However, 100,000 tons of rubber will require more than a million acres of land. 150 trees per acre, instead of being assumed as the average, should be regarded as the maximum of density, as a dangerous maximum in fact, considering the warnings we have had already regarding contagious plant disease. Planters know by practical experience that healthy *Heveas* under favourable conditions add more than a foot per annum to the radius of their feeding rootlets, and at 15×20 or at 17×17 feet it does not take long to figure out the number of years from first planting when they will have formed a dense web of fibre underground. And the struggle for existence carried on simultaneously by the branches overhead means so many additional points of contact and possible contagion.

At the close of the lecture the discussion was opened by *Mr. Kelway Bamber*, Government Analytical Chemist, who pointed out that the rubbers now grown in Ceylon, being all deciduous trees, restored to the soil in leaf mould practically all that they took out of it. But he was in agreement with the lecturer as to the danger of close planting and had remarked with regret, on his way up to Peradeniya from Colombo, that at the plantation visited from the train, the intervals did not exceed $8' \times 8'$. True, rubber took

nothing out of the soil to the extent that other crops did, yet the discriminating use of manure was of great importance, especially in the earlier stages of growth. In some cases forcing manures had been resorted to, producing high but feeble trees, liable to destruction by strong winds. This was an error, but organic matter as manure was nevertheless essential. That the nutrition of the trees was not everywhere attended to as it deserved, was, the speaker thought, indicated by an increase in fluidity of the latex, the departure from the normal 32 per cent. of caoutchouc showing in some cases as great a fall as 15 per cent.

H. E. the Governor here inquired whether this alteration in the character of the latex was not rather an increase in fluidity than a diminution of the obtainable percentage of caoutchouc per tree. Messrs. Bamber and Wright agreed that this was so—the caoutchouc was constant, but the fluid bulk had increased.

Dr. Christy pointed out that in Ceylon but little attention had been given to the practice of smoking the rubber. They all knew that in the Amazon Valley the Indian prepared his bucketful of latex by repeatedly dipping a spatula in it and drying the successive layers of rubber fluid over the smoke of *Palas* nuts burnt in a small kiln, the shape of an inverted flower-pot. Speaking from a personal knowledge of Africa and African rubbers, he remarked that *Funtumia* latex prepared in this way could be made into a caoutchouc equalling Para. Africa, with this rubber, might, he feared, prove a formidable competitor to Ceylon, seeing that the *Funtumia,* unlike the *Hevea,* was a gregarious tree, often found in patches at a density of 200 trees per acre in its native forests.

Mr. Wright inquired whether Ceylon was not neglecting the possibilities of the smoke-cured, and at the same time going too far in the washing processes. For one thing, by eliminating proteids and resins, we lost weight on the commercial product, whereas the wild rubber of the Amazon finds a ready market with all its proteids and much of its water left in it, merely by the addition

of an antiseptic (creasote), for that is what smoking practically amounts to.

At this stage *Dr. Willis* produced a sample of Amazon rubber exhibited by Messrs. Lewis, Peat, London, in the state in which it was received from Para., but cut open to show its formation. It was noted that this sample, weighing some 10 or 12 lbs., was quite damp in the core and smelt of creasote; also that the successive layers, as they dried and contracted, exercised a great compression upon the interior mass. Its resiliency was far greater than anything manifested by the local or Straits samples.

Dr. Bamber here noticed one point that was often overlooked, namely, that in the planter's washing and drying houses there was just as much necessity for sterilization as in a well-managed dairy. The inoculation of a sound biscuit or sheet from a tainted one was a very simple matter and could easily occur by mere contact.

Mr. Ryan said that for coagulation pyroligneous acid was really a cheaper and better agency than the acetic acid now used. Planters who had tried a creasote had complained to him of the difficulty of getting it to mix with the latex. But if they would prepare it with alcohol in the proportion of ten parts of the former to one of the latter, they would find it incorporate with their latex quite easily. As to the general prospects of the rubber-planting industry, he considered the great danger to be that about 1910-1913 the world would be flooded with plantation rubber now being sown, and the history of quinine planting in Ceylon would be repeated.

Mr. Carruthers (*Straits*) said that it was a mistake to go too exclusively for chemical purity. We have sent samples of our stuff from the Straits to the Silvertown Rubber Works for commercial test and at the same time to the Imperial Institute for chemical analysis. Our crepe rubber was favourably reported upon at first, but chemical analysis showed that our sheet rubber was purer. However, the preference shown by the commercial experts for our crepe proved to us that mere purity was not appreciated. As to some of the gloomy predictions we have heard to-day, the facts and figures do not justify them altogether. The latter are fallacious in at least one point. The speaker who used the expression "lands alienated

for rubber cultivation " seemed to imply that such lands were necessarily under cultivation. That is a matter for the individual planter who holds them. He may take a thousand acres and only bring two hundred under cultivation, reserving the rest for next year or for three years hence.

After a paper had been read from an absent member, who suggested that the State should decide on what lands rubber should or should not be grown, a proposal which did not commend itself to the meeting, His Excellency the Governor proposed a vote of thanks to Mr. Wright for his able lecture, and thanked the gentlemen taking part in the discussion for the light thrown by them on the question generally.

The afternoon lecture by *Dr. Willis*, on *Cotton as a catch crop among Rubber*, was a very brief one, as the subject had been dealt with by him in a previous set of lectures now available in the form of an official publication. He emphasized the point that what he called "Wet Ceylon," where in fact most of the rubber of the Island was being grown, was unsuited to cotton growing, but that there were regions in the Northern Provinces now for the first time opened out by railway communication, where cotton had every prospect of success. Sea Island cotton was undoubtedly the best of the perennials, yielding as it did 116 lbs. lint and 286 lbs. seed per acre at a cost of production of Rs. 45, he hoped by improved methods to be able soon to say Rs. 35 per acre. But even now a return of Rs. 45 per acre might at present prices be counted upon. In selecting seed for planting, the lecturer warned planters of the practical objections to a mixture of varieties. Egyptian cotton gave an inferior but much more abundant crop than Sea Island, and Upland cotton a still poorer but still more copious one. If these three kinds were not kept well apart in the plantation, with a clear space of a quarter of a mile or so between each, over which coolies could not pass without being noticed, they would conceal themselves under the trees and fill their baskets mainly from the more abundant bolls, bringing in loads of nominal Sea Island, but containing the two inferior varieties and reducing the market value of the lot.

He insisted on the necessity for careful selection of seed to avoid deterioration, and selection only from the plants giving the longer staples. Anything over an inch and a half in lint was good, and every additional fraction counted. But the lecturer could not commend cotton growing as an industry upon anything like the same scale as rubber.—(J. A. Wyllie.)

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Rubber experiments in Bombay:—The following extracts from the instructions, drawn up by Mr. W. E. Coplestone, Deputy Conservator of Forests, for the management of the Government Rubber Plantation in the Kanara forests of Bombay, will be of interest to all who are starting rubber plantations.

Seeds to be obtained.—*Para. rubber.*—Though seed of this species is available in small quantity from the end of June, the early seed germinates badly and would not give satisfactory results. After the capsule drops off and scatters its three seeds on the ground, Para. seed will not last more than ten days. If seeds are obtained when the majority of fruit is ripening, the required quantity can be collected in a day and packed off perfectly fresh.

As Para. rubber is by far the most valuable rubber-producing tree, every effort should be made to introduce this species. Should it thrive in Kánara a fine return is certain, whereas in the case of Ceara and Castilloa it is doubtful if the yield will repay the cost of cultivation. It seems probable that a Para. rubber tree will yield ten times the quantity of rubber that Ceara or Castilloa is likely to give. For the above reasons more Para. seed should be ordered than Ceara or Castilloa. The seed should be despatched from Ceylon by post in *double* bags weighing 6 lbs. or 11 lbs. each. Five rupees per 1,000 is the lowest price at which really reliable seed can be obtained at present. * * * * *

15,000 seed would be ample to plant up 30 acres with Para. 10′ × 10′, that is, 435 trees to the acre.

Ceara (*Manihot Glaziovii*).—Ceara seed will keep any length of time, and each seed must be filed to hasten germination. Without filing, the seed may be dormant for more than a year. The

filing may be done at the two sides of the seed, just rubbing away the hard integument * * *

Since writing the above I hear from Ceylon that Ceara seeds are now selling at Rs. 5 per 1,000.

In Ceylon the Ceara rubber tree grows rapidly, reaching a height of 30 feet and girth 20 inches in two years. It is, however, a small tree and seldom reaches 50 feet in height. It is deciduous and is leafless in the dry weather. Though it requires less moisture than the Para., the rainfall in the Ceara Province is much more evenly distributed than that of Kánara. Probably it will not stand more than one 30-day period of tapping (September) in Kánara.

Castilloa Elastica.—On July 3rd 5,000 Castilloa seed were sent to Honáver for sowing in the Gersoppa Nursery, also 1,000 to Yellápur for sowing there. The Superintendent, Kondesalle, Kandy, supplied 6,000 seed at Rs. 5 per 1,000 and charged Rs. 5 for packing and postage. * * * *

It is not intended to plant up a greater area with Castilloa than with Ceara, but a greater number of seed has been ordered, as it is expected that many of the seeds will fail to germinate. All seed should be obtained direct from the planters and not from dealers. The seeds should be sown an inch deep and should germinate within three weeks. The seedlings require light shade and watering. In Mexico the Castilloa grows to a huge size, but it cannot withstand much tapping.

Seeds of Shade Trees.—The young plants of Para. and Castilloa will require shade both in the nursery and in the plantations. During October to end of May the seedlings in the nursery may be *lightly* shaded in the same manner as the supári gardeners shade their cardamom and areca palm seedlings, and the positions they select, *viz.*, wet low-lying ground with good alluvial soil, are just the spots suitable to Para. seedlings, but the beds must be raised at least a foot and, if boggy, deep ditches 2 feet wide and $1\frac{1}{2}$ feet deep should be dug.

If artificially shaded, the palm leaves or grass, or whatever is used for laying over the framework of the shade, should be

at least two feet above the highest shoots of the seedlings. This shade must be light and should as far as possible simulate the shade of a tree with light foliage, such as the Albizzia, or rather a thin-topped Poinciana. As an experiment, one of the beds should not be shaded, but it is probable that the seedlings will require shade from October to June. During the rains the shade should be removed altogether. In the plantation, shade will be necessary probably for the first year during the dry season, but not during the rains. The only way to obtain this is to plant up the plantation with a suitable tree, such as an Albizzia, Erythrina or Peltophorum. A leguminous nitrogen-collecting tree is preferable. The two species which are in favour in Ceylon now are *Albizzia moluccana* and *Erythrina lithosperma.* The former grows very rapidly with a good spread, and the latter is a splendid green manure.

The first may thrive at the foot of the ghats and the latter above, but both should be tried at high and low level, and should either of these trees thrive, the supári gardeners should be encouraged to cultivate them near their gardens for "Soppu." Cuttings of Erythrina grow rapidly. The cuttings should be about 4′ to 5′ long and 6″ girth, and must be put in in June in heavy rain.

In the plantation these shade trees should be lopped at a height of about 5 feet, and should never be allowed to overtop the leading shoot of the rubber after the rubber plant has established itself.

Probably it will be found sufficient to shade the rubber from the time it is first put out in June until June of the following year, when the shade trees should be lopped back ruthlessly at a height of about 4 feet, taking off any side branches which may threaten to interfere with the rubber. This lopping should take place early in June, and the shade trees should be cut in such a manner as to prevent them from throwing shade over the tops of the rubber plants from June to September. From October the shade trees should be allowed to spread over the seedlings during their second dry season, after which they should not require further shade, and the shade trees should again be cut back in May or June. The loppings will always be left on the ground in the rains to check wash and enrich the soil.

Erythrina may be skinned of its leaves by hand-pruning or by cutting the small twigs off with a bill hook twice a year, once in June and again in September, and the prunings will be left on the ground for manure round the foot of the rubber. It is hardly worth while burying in the prunings. Some of the most experienced planters in Ceylon think very highly of "Dadap" (*Erythrina lithosperma*) as a manure. *Albizzia moluccana* also enriches the soil, but its chief value lies in its extraordinary rapid growth and power as a soil opener. The Albizzia is more useful in a rubber plantation than the Erythrina. The latter would be very useful for manuring supári gardens and sugar-cane, etc.* * * *

The price of *Erythrina lithosperma* (called "Dadap" in Ceylon) is Rs. 2 per lb. Probably about 2,500 seeds go to the lb. Seeds of Dadap have been forwarded to the Range Forest officers, Yellápur, Sirsi, Siddápur and Honáver. They should report the weight received. The Dadap is a small tree, and may in Kánara be planted $20' \times 20'$ or even $10' \times 10'$ for shades.

Albizzia Moluccana.—This tree, which grows very rapidly and to a great size, must be pollarded at about 4 feet. It should be planted $20' \times 20'$.

To help the rubber through the first two dry seasons, shade will be very necessary in Kánara, and about 5 acres of the Para. plantation should be planted $10' \times 10'$ with rubber, $20' \times 20'$ with *Albizzia moluccana*, and $20' \times 20'$ with *Erythrina lithosperma*, the remaining areas $10' \times 10'$ or $10' \times 20'$ with rubber and $20' \times 20'$ with either Albizzia or Erythrina.

Should these exotics fail, *Peltophorum* which has grown well and rapidly in the Empress Gardens at Poona, or some indigenous leguminous trees, may be substituted.

Another plot of an acre or two may be sown with *Crotolaria striata* to get a complete ground cover, and when the crop flowers, it should be buried in as green manure.

The shade bearers should be planted out next June over the whole plantation, whereas most of the rubber will be planted in June, 1908.

In the management of the plantation it must be kept in mind that Hevea is a greedy light-demander; Castilloa also requires to have its head quite free of shade, and it is only during the first year or two of the plant's life in the nursery and while the plants are getting a hold of the soil in the plantation that shade is necessary, but *this shade should be cut back as far as possible from June to the end of September.*

In Ceylon the Para. is not shaded as a rule either in the seed beds or in the plantations, but it is practically certain that the tree will not stand the long dry season with continual sun in Kánara without shade.

SELECTION OF NURSERY AND PLANTATION.—*Position, Aspect, etc.*—The Para. rubber is more likely to thrive below ghats than above. Ceara may grow in Yellápur or Kádra, the other two species should be tried chiefly below the big ever-greens of Malemane or in Bhatkal.

A rich, deep, alluvial soil, moist all the year round and with a good supply of water, is required for the Para. nursery. In selecting the plantation a damp steamy hollow shut in practically on all sides by hills, surrounded entirely with high evergreen and wet and boggy along the bottom of the valley, should be sought for. The plantation should not extend to exposed hill-tops, as the tree is very susceptible to winds, and the soil will all be washed away if the upper slopes are cleared. Avoid steep slopes, as it will be very difficult to prevent denudation with a rainfall of perhaps 60 inches in one month. A valley protected on the west by a hill closed with evergreen forest would shelter the trees from the evening sun. The Para. should be planted in the banks of the streams, and even deserted boggy rice-fields would suit it with a little draining.

The tree thrives in Ceylon on rocky steep hill-sides almost as well as on alluvial flats, and it can stand flooding for the greater part of the year, so that the plantation may include a little rocky ground as well as flat ground, though the bulk of the plantation should be nearly flat, and if possible the soil should be a rich deep alluvial deposit. In Kánara the trees along the banks of the larger

rivers often suffer from too much sun after the floods, and a valley drained by a small perennial stream would be preferable.

Orders have already been issued for 10-acre plantations at Yellápur and Kádra. The climate along the ghats of Honáver and Bhátkal appears to be much better suited to rubber trees. The forests above Gersoppa are more tropical than those of Yellápur and the flora is nearer that of the Malawan forests. If the seedlings at Yellápur and Kádra do not show vigorous growth, I would recommend reducing the 10-acre plantations to 5 acres (or abandon them), and chiefly Ceara should be tried in these places.

The officer in charge of the experiment will be more likely to get satisfactory results by concentrating his attention on one plantation, leaving the two small plantations to the Divisional Forest officers and their subordinates.

Elevation.—The coast climate is more suitable than the above ghat, but there are probably suitable sheltered areas below Malemane and Doddamane below 1,500 feet.

Rock and Soil.—Laterite should be avoided. Hills of granite gneiss or a rock rich in lime of similar composition to the Yam rocks (Dolomite) would give a suitable soil in the valleys below.

Climate.—The Gersoppa and Bhátkal temperature is more equable than in other parts of Kánara, and the range here from 70° to 95° is just what the rubber requires. The rainfall is not suitable anywhere in Kánara, but the humidity of atmosphere and soil is greater in the midst of large stretches of evergreen forest, such as one finds about Doddamane and Malemane, than elsewhere.

Method of clearing area for the Plantation.—Though the narrow, wet, deserted, grassy rice-fields found occasionally in the midst of large forest areas are suitable if clean weeded and drained, the growth of rubber will be more vigorous on an area freshly cleared of heavy jungle than on an area which has long been under grass and scrub; on no account should scrubby jungle be selected. In Ceylon everything is felled, and when dry it is burnt clean. This generally leads to denudation and waste

of much valuable leaf manure and humus. The better method is to cut (in November) all the small growth in the ever-green, that is, everything under a foot girth, leaving the upper canopy intact. Heap up this small material and burn it off when thoroughly dry, letting the fire spread over the whole area. Then line out the holes and dig them $1\frac{1}{2}$ to 2 feet deep and $2 \times 2\frac{1}{2}$. Spread the dug-out earth in a crescent form on the lower side of the hole or, on level ground, throw it out over the burnt ashes to prevent them from being washed away. The object of putting the dug-out earth on the lower side of the hole is to form a miniature dam to catch the minute organic matter washed down in the rains. This will manure the rubber trees.

This dug-out soil and gravel is never put back in the hole, but as soon as the holes are dug, good rich black earth, such as one finds immediately below the dead leaves in an evergreen, is scraped up from the higher side of the hole and at 3 or 4 feet distance from it, and the hole is filled with this earth and left in this state for 5 or 6 months before the planting takes place. This holing and filling in would be done in December or January before planting out. As most of the plants in Kánara will remain in the nursery from September to the June of the second year, that is, 21 months, holing for the rubber will be partly done in December 1906 and partly in December 1907.

As soon as the work of cutting and burning the small trees and undergrowth and of lining out, holding and filling up the holes is complete, the large trees must be felled and the branches lopped off and burnt, any valuable timber should be removed *immediately* and all the soft wood may be left to rot. The branches may be removed for firewood or heaped up for burning, and the leaves and small twigs should be left on the ground to protect the ash of the former burning from wash. In making this final burning the branch wood should be burnt heap by heap, and it would be better not to let the fire spread over the whole area during this second burning.

The advantages of having a preliminary burning of the undergrowth are—

(1) The ash is protected by the leaves which fall from the over-wood. Many of the big trees will suffer from the fire, and the ground should be well covered by leaf before the final clearing.

(2) The felling and handling of the big timber is easy when not incumbered with the undergrowth.

(3) Valuable timber is not damaged by fire. The felling is done at about 2 feet height. Usually the stumps of the trees are left standing about 2 feet high. With evergreen species these will soon disappear.

As a rule, in Ceylon the rubber is planted out as "stumps." A stump is usually a 9-month old seedling in Ceylon, and a 9-month seedling grown in a suitable climate is from 3 to 6 feet high with a tap-root 1 to 3 feet long. About one-half of the main shoot is soft with green bark and the lower half is woody with grey bark. The plant is stumped just above the spot where the grey bark ends by cutting most of the leading shoot off with a *koita*. This leaves the plant leafless and gives the root system a chance to get a hold of the soil before the fresh leaves appear. Various methods of planting should be tried with Para. At least $\frac{5}{8}$ths of the area should be planted up with 21-month old stumps, $\frac{2}{8}$ths with 9-month old stumps, and the remaining $\frac{1}{8}$th with 3 or 4-month old seedlings in bamboo baskets and not stumped. June is the month for planting. Except the basket planting, no planting should be done on a dry day.

Basket Planting.—The bamboo baskets could be made in Kánara at about Rs. 2 per 1,000. They should be about 6″ diameter at the mouth and 15″ deep, tapering to a point. * * The baskets are filled with rich soil and one germinated seed is placed in each basket, the seed being lightly covered with fine earth. The baskets are placed touching one another, and all the interstices are well packed with earth.

The Para. seeds should be placed almost touching one another on the germinating bed and should be three parts covered with fine sandy earth. The seed must be regularly watered if not rained upon daily. Germination should take place within a week, and the bed must be picked over carefully daily while the seeds are

germinating. As soon as a seed germinates, it must be placed in a basket.

About 3,000 Para. seed should be treated in this manner. This may be sufficient to plant up about 6 acres with 435 plants an acre. Each of these young basket plants should be protected from animals by putting round it a small bamboo *tatti* made of split bamboo about 2 feet in diameter at base, 3 feet at top, and 2 to 3 feet high, sinking the bamboo about 3″ in the ground.

It will be necessary to water these plants from the day they are put in up to June, for the first week daily and afterwards every second or third day. Should they show signs of drying up, a light cover of grass may be placed over the top of the bamboo protector during the hot weather. As animals are very fond of young rubber shoots, the bamboo or palm leaf guards are necessary.

The remaining 12,000 Para. seed will be sown at intervals of about 1 foot in the seed beds, each bed being raised about 1 to 1½ feet above the level of the 2-feet paths between the beds. The seed should be barely covered with fine earth. When there is no rain, the beds must be regularly watered. Ceara seed must be filed. Both Castilloa and Ceara will be sown at intervals roughly of 6 to 12 inches. Both require about 3 weeks to germinate.

Fencing of Nursery.—Wire netting with 1-inch mesh is useful in keeping out hares, etc. As the nursery fence is only to last 2 years, bamboo will suffice. The fence should be 5 feet high, and for a height of 2 feet the bamboos should be touching one another. so that hares cannot get through. To prevent pigs from breaking through, the fence must be supported with fairly strong uprights.

Fencing the Plantations.—Barbed-wire fencing is necessary, and it must be kept in perfect order and inspected daily by the forest guard in charge. The wire fencing alone is not sufficient to keep cattle and deer out, and the fence should be strengthened with stout 8-feet dowgi bamboos put in slanting with about 2 feet of thin side branches left on them. Each bamboo must be intertwined in the wire or fastened to it with wire ties and must be pushed into the ground bringing the height of the fence up to 4½ or 5 feet. The Government plantations in Tenasserim and

in South Kánara have been partially ruined by cattle and deer as they were not well fenced.

Draining.—Swampy land must be well drained with good deep drains intersecting at distances of 20 to 30 feet; the earth and stuff dug out helps to raise the plants above the water-level. On hill-sides drains at intervals of about 30 feet with a gradient of about 1 in 25 prevent wash in the heavy rains.

These drains should be dug 2 feet by $1\frac{1}{2}$ deep, and the soil taken out should be spread over the top of the ashes before the thunderstorms come on. On steep rocky slopes the ground has to be terraced at intervals of 30 feet with low rough stone walls a foot or two high. This prevents wash. The cost of draining or terracing would be about Rs. 5 an acre.

TIME FOR MAKING CLEARINGS, ETC.—*1st Clearing.*—To be planted up with 3-month old basket plants. The various methods of planting have been sketched out above. For the basket planting a small area of about 3 acres must be completely cleared and holed out by the end of November next. This should be planted up with basket plants as soon as cleared and fast growing shade trees should be introduced. Another 3 acres should be cleared of undergrowth and most of the trees, leaving only a few small shade trees. If suitable trees are not found, the whole 6 acres must be completely cleared and burnt off at the end of November; suitable shade trees will then be introduced.

2nd Clearing.—Another area of about 12 acres will be cleared of undergrowth and burnt off in November and holed out. The trees will be felled and the branch-wood burnt in January or February. Nine-month old stumps will be put out in this area in June. Also shade trees should be introduced as soon as possible.

3rd Clearing.—The remaining area of about 30 acres will be cleared of undergrowth in November or December 1907, holed in December or January, and tree growth felled and branch-wood burnt off in February 1908. This area will be planted up with 1-month old stumps in June 1908. Shade trees should be put out as soon as possible after clearing.

N. B.—Should the *Para.* rubber in the nurseries and in clearings 1 and 2 be a failure and not show satisfactory growth, this 3rd clearing should not be made.

TIME FOR PLANTING.—6 acres to be planted up in December 1906 with basket plants.

12 acres to be in June 1907 with 9-month stumps.

30 ,, ,, in June 1908 with 21-month old stumps.

TIME FOR FENCING.—The fencing cannot well be done before the area is cleared and the 6 acres planted up. The 12 acres clearing in December 1906 should be situated at one end of the area selected for the plantation, and may be wire-fenced with a permanent fence on one side and closed with a temporary fence, such as the Kumriwalas make of felled trees on the other sides. The permanent fencing will be completed after the 30 acres clearing is made in February 1908.

RATE OF GROWTH.—The rate of growth both in the nurseries and in the plantations will indicate the future prospects. The height, growth and girth increment at 3 feet from the ground should be carefully noted and recorded twice a year. The measurements of certain trees should be taken about June 1st, just before the monsoon, and again about November 1st.

The growth of artificially-watered plants will not be a true test of the suitability of the climate, and it will be necessary to keep a record of at least 20 of the plants which will be put out in June 1906. A numbered post or stone will be placed adjacent to each test plant. To get a satisfactory yield, the growth of the trees must be vigorous. In Ceylon, young Para. seedlings grow 6 feet in height and 3 inches in girth during the first year. The mean annual increment during the first to fifth year should be 4 inches in circumference and 5 feet in height.

By the end of the fourth year the tree may be large enough for tapping. In the Ceylon plantations the 5-year old rubber averages from 25 to 30 feet in height and over 20 inches in girth at 3 feet from the ground. From a commercial point of view the rate of growth during the first few years of the life of the Para. tree

is very important. In Ceylon, South India and the F. M. S., plantations which do not show an average annual increment of 4 inches (girth) are not regarded as satisfactory. In the best rubber districts in Ceylon straight grown Para. plants, which had been 9 months in the nursery and 3 years in the plantations, usually exceeded 20 feet in height. From the reports on the Malay plantations the growth there seems even more rapid.

As the latex is chiefly stored up in the lower 10 feet of the tree, diameter growth is more important than height growth, though the latter indicates the suitability of the soil. Unless the diameter growth of uninjured plants during the first five years after the plants have been put out in the plantation exceeds 3 inches per annum at 3 feet from the base, the climate cannot be considered suitable for Para.

METHOD OF HASTENING DIAMETER GROWTH.—Usually the young Para. tree developes a straight stem of 20 feet with scarcely any side branches; most of the 30-year old trees at Heneratgoda have long straight stems without branches to a height of 30 to 50 feet, the total height being about 80 to 90 feet. There are also some trees branched low down in these gardens, and these forked trees have a much greater diameter. In fact, the girth of the forked trees runs to nearly 100 inches, whereas the straight-grown tree is less than 70 inches in circumference. By thumb nail pruning of the terminal bud, branching can be induced. In the Perideniya gardens there were two 2-year old straight-grown trees of equal girth. One of these was thumb-nail-pruned in February. I measured them on the 26th June and the pruned tree exceeded the other in girth by $\frac{3}{8}$ths of an inch. Generally the girth increment of a forked or well-branched tree would be nearly one inch a year above that of the clean-grown tree.

As high tapping is laborious and expensive and since the latex is stored chiefly in the lower parts of the tree, the advantages of rapid girth-growth are obvious. A 2 or 3-year old tree carefully pruned often carries four times as many leaves as a non-branched tree of the same age; hence the girth increment of the pruned tree is more rapid, and it is likely to reach the minimum tapping size

(say 20-inch girth) in 4 years, while the straight clean-grown tree would not reach this dimension in less than 5 years. The branching tree saves much weeding and protects the surface soil. Should the Para. in Kánara reach a height of 8 to 10 feet at the end of two years in the plantation, I would strongly advocate pruning by hand. This can easily be done by bending over the tree and nipping off the terminal bud, taking off about a quarter of an inch with the thumb nail. The wound is protected almost instantaneously by a flow of latex, and there is little chance of the nectria fungus or any other disease getting in.

PROTECTION FROM FIRE.—Para. rubber is extremely sensitive to fire, and no grass or inflammable matter should be left in the plantation during the dry season. Nothing should be burnt even in the near neighbourhood. I have seen a plantation badly damaged by the hot air from the burning of a neighbouring clearing.

NOTES ON CULTIVATION OF CAMPHOR.—Camphor is not cultivated extensively in Ceylon, and not much information about the œcology of the plant was available. I visited the Government Camphor Plantation at Hakgola, 6 miles out of Newara-Eliya, elevation 5,600 feet. The tree seems to adapt itself to various climatic conditions as it thrives almost from sea-level to 6,000 feet. From my observations I see no reason why the camphor tree should not thrive in Kánara and, as an experiment, it should be planted in each rubber plantation between the rubber trees.

A few seeds were sown about 2-years ago in Kánara, and the Conservator of Forests, S. C., in his No. 887, printed under Government Resolution No. 4877 of 18th May 1906, states that the plants have done well. I saw the small seedling plants about 2 years ago, and only have a vague recollection of the shape of the leaf. However, I think it worth while to record that I doubt if we have got hold of the right species, *viz.*, *Cinnamomum camphora*. The Japanese have always tried to prevent the export of the seed. The leaf of the Ceylon species, which is undoubtedly the plant we require—for the percentage of camphor obtained from it is exception-

ally high—is broader than the leaves of the Kánara plant. The leaves, fresh or dry, should give a strong smell of camphor when crumpled up in the hand. The Divisional Forest Officer, N. D., Kánara, informs me that the leaves of his plants give no smell of camphor. To clear up the question I have sent species of the true camphor to the Conservator of Forests, S. C.

The *Cinnamomum camphora* is a huge evergreen tree in Formosa and Japan, and I think it should thrive best if grown somewhere in the vicinity of Malemane, between the Malemane and Mensi forest posts. Owing to its use in the manufacture of explosives, the consumption of camphor has increased, and its price has risen considerably during the last 10 years. In 1895 the price was £8 to £9 per cwt. There was a rise to £20 during the Chino-Japanese War, and at present the price is about £20 a cwt. The world's consumption is estimated at 6 to 7 million pounds, and it is believed that Japan and Formosa can supply all this. According to the estimated outturn per acre in Ceylon, the planting up of 15 to 20 thousand acres would supply the whole 7 million pounds.

In New York a company for the production of camphor by synthesis has been formed. Its capital is a million dollars and it has plant for an annual outturn of two million pounds. The crude material employed in the manufacture is turpentine oil, yielding 98 lbs. of camphor per barrel (36 gallons). It is important to note that the cost of production in America by synthesis is considerably higher than the cost of producing camphor from the tree in Ceylon. At the same time it must be remembered that the demand is limited, and the cultivation of the plant in Kánara should be limited to inexpensive experiments which might put us in a position to plant extensively in case of a sudden increased demand.

It is very difficult to obtain seeds in any quantity, and when obtained, the germination is irregular. Seeds at half a crown per lb. are advertised by the Yokohama Seeds Nursery, Nos. 21 to 35, Nakamura, Yokohama. The seed is about the size of a round (*sic.*) and black, weighing about 7,000 to the pound. November is the month to obtain seed fresh, and as it does not last long, it should be sent

by parcel-post and sown immediately on arrival. Soak the seed in water for 24 hours or more, sow in a rich sandy loam, covering the seed with about $\frac{3}{4}$ths of an inch of fine earth. To preserve an even degree of moisture the beds should be well shaded. The seeds are best sown in boxes (18″ × 4″) handy for moving about. The soil should be kept damp, but not too wet.

The small seedlings should be very carefully transferred to baskets, and should be shaded and watered until the plants begin to grow, when they should be gradually exposed to the sun. When 9″ to 15″ high, the plants may be put out on a dull showery day in June. In dry weather mulch the soil thickly with *Soppu.* The camphor is obtained by distilling the fresh young shoots which are clipped off with shears, taking 6″ to 8″ off. Ordinarily the plants should not be allowed to grow into high trees, but should be kept down as bushes about 4 feet high. It would be advisable to allow a few trees to grow up with a view to obtaining seed.—(W. E. Copleston.)

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DISEASES OF GRAPE VINES IN THE DECCAN.—Grapes are grown for the fresh fruit in the Ahmednagar, Nasik, Satara and Poona Districts of the Bombay Presidency and in parts of the Nizam's Dominions. In a recent Bulletin of the Agri-Horticultural Society of Western India, a brief account is given by Mr. P. S. Kanetkar, Superintendent of the Empress and Bund Gardens, Poona, of the methods of cultivation, varieties, and some of the troubles met with by the growers in the Deccan. As in other countries, fungus diseases are amongst the chief of the latter. Four are mentioned, under the vernacular names of *Kharda rog* (red or brown rust), *Buri* (mildew), *Khajalya rog* (black rust), and *Karpa rog* (drying up disease). The second and fourth of these are well-known diseases of the vine which have caused great losses in Europe. *Bhuri*, or mildew, is the disease which, appearing first in England in 1845, ravaged the vineyards of France in the middle of the last century. It is caused by *Oidium tuckeri*, one of the most destructive of the mildew family. Fortunately it can be controlled

by the use of sulphur, applied as the flowers of sulphur, dusted on the leaves by means of a bellows, or even, as Mr. Kanetkar suggests, shaken through a muslin bag. Persistently applied, this has given good results at Poona. It is a routine practice in many parts of France, where it is looked on as much a part of the ordinary vineyard cultivation as weeding or pruning, and owing to this treatment over a large area, the disease has ceased to be very serious in Europe. *Karpa rog* is equally well known in Europe under the name of "anthracnose," being caused by the fungus *Sphaceloma ampelinum*. The young branches are attacked by brown patches, which eat into the bark ; as a result they dry up and blacken, as if burnt. The fruit is also frequently attacked and spoiled, and in bad cases the vines eventually die. In the treatment of this disease, sulphur may also be employed with good results at the beginning of an attack. The best remedy is, however, swabbing all the diseased branches with a rag brush dipped into a solution of iron sulphate and sulphuric acid, of a strength of fifty parts of iron sulphate, one part of sulphuric acid and one hundred parts of water.—(E. J. Butler.)

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SPRAYING POTATOES.—Experiments carried out in Shillong this year, by the Eastern Bengal and Assam Department of Agriculture, yielded good results. The experiments were in duplicate, each including four plots which were treated alike, except in regard to the spraying. One of the four plots was sprayed three times during the growing season with plain Bordeaux mixture, the second with Bordeaux mixture to which a small quantity of rosin and soda solution was added to make it adhesive, the third with Bordeaux mixture to which *gur* was added with the same view, and the fourth was left unsprayed. It has been found that the excessive rain during the growing season in the Khasi Hills makes it difficult to get the mixture to adhere to the foliage, without the addition of some adhesive substance. The quantity of Bordeaux mixture used in the first three plots was 300 gallons per acre, *viz.*, 60 gallons at the first application, and 120 at each of the others.

The yield per acre and cost of the treatment of the different plots were as below:—

	First series.	Second series.	Average of two series.	Excess of yield due to spraying.	Value of excess yield at Rs. 1-4-0 per maund.	Cost of spraying.	Profit due to spraying.
1	2	3	4	5	6	7	8
	Mds.	Mds.	Mds.	Mds.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Plain Bordeaux mixture.	144	133	138½	50	62 8 0	12 9 6	49 14 6
Bordeaux mixture with rosin and soda.	147	158	152½	64	80 0 0	19 10 0	60 6 0
Bordeaux mixture with *gur*.	125	158	141½	53	66 4 0	15 3 9	51 0 3
Unsprayed ...	106	71	88½	...	.....	......	...

The sprayed plots show a substantial profit.—(E. J. Butler.)

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PROTECTIVE WIND BELTS.—The Director of Agriculture and Government Botanist, Federated Malay States, has carried out experiments which indicate the value of protective wind belts in checking the spread of disease, in the case of crops which cover a large area continuously. Some experiments with jute hessian screens, made previously on Ceylon tea estates, showed clearly the value of a mechanical protection from the attacks of wind-borne spores. The screens were erected at right angles to the prevailing winds, and the appearance of leaf fungi, to leeward and to windward respectively, carefully observed. The bushes to leeward were much less affected than those to windward. In the Malay Peninsula these experiments are being put to practical test in the rubber-planting districts, so that these may be as far as possible divided off by belts of jungle, in such a manner that the outbreak of disease in one locality may be confined within limits, and plantations in other parts may either be preserved from the evil, or at any rate protected for a time. In temperate climates the spread of fungus pests is checked by the advent of winter, but in tropical countries the climatic conditions are often such as to afford almost perfect conditions for the spread of disease all the

year round. That many crops are not entirely destroyed by parasitic disease is due to the fact that most crops are grown in patches with often considerable gaps between one field and the next, and the intervention of other crops which are not liable to the same disease. Anything which may tend to produce the same conditions with crops, such as tea, coffee, rubber, cinchona and the like, should exercise a certain amount of check on the spread of wind-borne diseases.—(E. J. Butler.)

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MULBERRY DISEASE IN KASHMIR.—The State mulberry plantations near Srinagar were this year seriously attacked by a disease, which has not previously been recorded in India. It is said to have occurred before in former years, but has never been described, nor the cause of it determined. This year it was worse than hitherto, possibly owing to the unusally severe winter of 1905-6 in Kashmir. The disease is found in old trees without causing appreciable damage; but it does great harm to the young plants in the nurseries, attacking the seedlings in their second or subsequent years. It does not kill them outright, but they have to be cut back below the diseased parts, thus losing several years' growth even if they are not attacked again. The disease is caused by a parasitic fungus (*Coryneum mori*), which invades the wood or the branches and comes to the surface to form spores. The latter are produced in little black, broken patches visible on the bark. The result is the withering of the young branches, which drop their leaves. The parasite has previously only been found in Japan, where it was first described in 1904, and it is an interesting problem how it has come to occur in these two countries without having been observed elsewhere. We know nothing of the parasitic fungi of the countries intervening between India and Japan, such as China, Burma and the neighbouring countries, and it is possible that the fungus is found continuously on the various species of mulberry which occur in these regions, either cultivated or wild. In this case it may have spread either from India to Japan, or from Japan to India. A more likely explanation, however, is that it has been introduced into India from Japan, during some of the

attempts which have been made to apply Japanese methods in the silk industry of India. How serious the disease is likely to prove it is not yet possible to predict, nor whether it can be easily controlled. It seems clear that much may be done to lessen its attacks by pruning off all diseased parts and burning them. It is to be hoped that the Kashmir Durbar will be able to secure a thorough investigation of this new pest, and adopt measures to stamp it out and prevent its spread into India proper.—(E. J. Butler.)

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THE MIXTURE OF WHEAT VARIETIES IN INDIA.—In a previous note (Vol. 1, p. 401), the possibility that wheat seed, left on the ground at reaping time, escaped germination during the summer and formed part of the next crop, was discussed. It was mentioned that this might take place in districts like the irrigated wheat tracts of the Punjab, where the summer temperature is so high and the rainfall during the monsoon so small. During November last, some observations were made on this point at the Lyallpur experiment station and in the neighbourhood. In both barley and oat fields, as well as those under wheat last year, seedlings of these cereals were found often in abundance at sowing time. Many of these would no doubt be destroyed in the final operations of ploughing and sowing, but a few might easily survive and thus lead to admixture of types in case a different variety of wheat was sown on the land for the succeeding crop.

The ants, which are so busy at harvest-time, burying stray wheat grains, are also active at sowing time. They remove from the surface any seeds left by the hanger and carry them some distance. It is quite possible, therefore, for some slight admixture to take place by this means between two different varieties sown in adjoining plots, even though each of the varieties was sown absolutely pure.

These difficulties, of course, mostly concern those engaged in testing different varieties of crops of this nature. They are interesting in view of the fact that statements are sometimes made as to the change of type of one wheat into something quite different.

Before such statements can be accepted, it is obvious that the possibility of errors such as these creeping into the work must be excluded.—(A. Howard.)

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Volunteer Wheat and Rust.—In some countries the outbreak of rust in wheat is ascribed to the carrying over of the parasite, in its living infective state, on "volunteer" wheat, *i.e.*, self-sown wheat which grows in the interval between two crops. In the United States, for instance, such wheat may be found all the year round, and fresh rust spores have been gathered and germinated almost every month of the year. In the plains of India self-sown wheat is very rare in the hot weather, and after the crop is cut, no plants can usually be found until the next crop is sown. Some experiments have been made at the Cawnpore Agricultural Station by Mr. J. M. Hayman, to endeavour to raise wheat plants in the hot weather and rains, with a view to ascertain whether rust can be carried over on them to the new season's crop. The results confirm the opinion that rust is not propagated in this way in Northern India. Plants, sown early in the hot weather, feebly headed out towards the end of July, but produced no seed. They showed that two generations at least would be required to carry wheat over the gap between two seasons. No trace of rust was found, though the wheat grown was an extremely susceptible one. Hence, even if feeble plants struggle through the hot weather, it is unlikely that they can become infected with rust. It has previously been proved in India that the rust spores cannot survive exposure to such heat as is experienced in the hot weather months. To explain the annual appearance of rust in India through the medium of volunteer wheat, it is necessary to assume a combination of favourable conditions greater than the imagination can easily accept. The seed would have to be cast in a shady locality; it would have to escape squirrels and other pests, which at Cawnpore ate all that was not specially enclosed; it would have to mature its grain, re-sow it and produce a second generation in the rains; and all this time it would have to be exposed, at frequent intervals, to infection from spores which themselves are very susceptible

to heat, and would have to be protected from it by lying under leaves or soil until some cause brings them in contact with the wheat. Even after contact, infection would not occur in the absence of moisture, and moisture on the leaves of plants is rare in the hot weather. The problem of the transmission of rust from season to season is still far from being solved.—(E. J. Butler.)

LITERATURE.

Report on the working of the Imperial Department of Agriculture for the West Indies.—(*Government Colonial Report. Price*, 1*s*. 4*d*.).

An interesting report has been issued on the working of the West Indian Agricultural Department for the years 1898-1906. The department was instituted, on the recommendation of the West Indian Royal Commission, to suggest measures for the restoration and maintenance of the prosperity of these colonies; it was created for ten years only in the belief that a Scientific Agricultural Department could do much to bring prosperity to these Islands, which were then in an impoverished condition. At the head of it was placed the present Commissioner, Sir Daniel Morris, K.C.M.G., who acted as Secretary to the Commission, and who has organized and administered the department throughout. Remembering the problem before Sir Daniel Morris, and the local conditions, has the scientific development of agriculture been able to increase the material prosperity of these Islands, and has the money voted by the Imperial Government been expended in the form most remunerative to the inhabitants of the Islands? Practically, this is a question now asked by the Home Government, the answer to which is given in this report. The opinions expressed by all the Agricultural Societies of the Islands is that the department has brought them very material assistance far out of proportion to the small sums expended, and they have asked their respective Governments to contribute to the upkeep of the department, believing it to be a sound thing. Thus, in the opinion of the persons concerned, the planters, a Scientific Department of Agriculture

has not only "paid" but paid handsomely, and the department emerges triumphant from the test.

Turning now to the report itself, we find that the expenditure has averaged £17,400 (Rs. 2,61,000) annually, of which £5,000 (Rs. 75,000) are expended on salaries and head office expenses, the balance on grants-in-aid. There have been practically three main problems—(1) the improvement of the sugarcane industry; (2) the introduction or improvement of subsidiary industries; (3) the spread of agricultural education among all classes, including labourers and small cultivators, so that improved methods could be introduced and understood.

Perhaps the most striking success of the department has been the replacement of the old diseased Bourbon cane with new varieties, and especially with seedlings produced in the Islands. In Barbados alone, over 20,000 new seedling canes have been reared, brought to cultivation experimentally, tested in the field and laboratory, and rigidly rejected if not up to standard. Less than one per cent. have passed the tests, but those issued for cultivation are now grown in large areas in the West Indies and also in the United States. This is a success of the first order, one which owes much to the local officers, Messrs. Bovell and d'Albuquerque, but which could not have been carried to completion without the Imperial Department. This has been repeated in Antigua and British Guiana, and the improved position of the sugar industry owes much to these new canes. Further, a very large series of manurial experiments have been conducted. It is perhaps difficult to understand how closely West Indian planters study manuring problems, until we realize that the growing of a successful crop there, yielding two to three tons of clean dry sugar per acre, is largely a matter of manuring. The Department has been of great assistance especially in Antigua, where Dr. Watts has conducted exhaustive experiments; and the extremely thorough experiments in Barbados may be expected to yield results when they are worked out to a finish and the conclusions arrived at. Success has been attained also in the matter of the establishment of the Antigua Central Factory: the industry in some Islands is probably dependent

upon the establishment of Central Factories and the working of the Antigua Factory will be followed with close attention.

The department has also paid attention to the subsidiary industries, dependent on the lime, cacao, coffee, banana and other products, and has specially benefited them by the maintenance of the Botanic Gardens, from which are issued economic plants. For many of these industries, the chief requisite is the production of large numbers of plants of the best varieties, and it is mainly to this economic problem that the energies of the Botanic Gardens are directed. The Dominica garden, for instance, issues yearly enormous quantities of the best varieties of plants, and has scored a success in the spineless lime, a plant of the greatest value to growers of lime-juice. Similarly for cacao, the best varieties were tested and issued, and manurial experiments have been carried out on estates in the Islands. Disease is a prominent feature of this crop, and the planters are now in a position to control these diseases under the advice of the officers of the department. Fruit is an important industry, and to the department is wholly due the credit of initiating the profitable trade in the improved Chinese banana grown in Barbados and sent to England; these bananas are now the most in demand in the English market. This line of attack is being proved for all tropical fruits grown there, and it looks as if the West Indies would soon supply the English markets with every kind of tropical fruit. The establishment of this industry means not only the growing of the fruit but its disposal in the markets in England, often the most difficult part of the work. In 1900, the department commenced experimenting with cotton, in the belief that good cotton could be grown and would pay. In 1902, 500 acres were under experimental cultivation; in 1905, 3,755 bales of cotton of the value of £45,585 (Rs. 6,83,775) were exported from these Islands, and the cotton produced is of such good quality that it fetches two to three annas per lb. more than the best American Sea Island cotton (average price, 14½ annas per lb.). This is an asset of no mean value, due wholly to the initiative of the department and providing planters and cultivators with a very remunerative subsidiary crop to sugarcane. Other crops have been

experimented with, including rice, limes, tobacco, rubber and sisal hemp, in all of which progress is being made.

The department commenced at once to initiate agricultural education in colleges, to start agricultural schools and to send agricultural instructors throughout the Islands. It is impossible to estimate the value of these efforts in so short a time, and the present generation will scarcely show much response. The agricultural schools have given a practical training to youths designed to be overseers on estates, and many planters have benefited from the lecture courses. The teaching at Harrison College has been of so high a quality that students have been brilliantly successful at the English Universites. The publications of the departments have had an extraordinary educative value among planters, the "Agricultural News" being perhaps one of the most successful publications of any Agricultural Department.

Finally, there are the many benefits that such a department confers in intangible ways: the checking of plant diseases, the study of insect pests, the treatment of cattle diseases, the introduction of good cattle and fowls, the initiation of legislative efforts to prevent the introduction of pests and diseases. All these are of vital importance, and if their importance cannot be gauged in pounds sterling, they are not of the less value. The department has been a training ground for scientists, some of whom are now in Agricultural Departments elsewhere, and it is not too much to say that they endorse the hope that their present departments will emerge as triumphantly from such a test. We have not space to deal with anything but the actual report, though the scientific papers attached are of great value. The report itself, though brief, is of peculiar interest, and we wish the department a long life, and as great a measure of success in the future as it has attained in the past. Its success may be said to be due to the directive and administrative ability of the Imperial Commissioner, Sir Daniel Morris, K.C.M.G., who has controlled it since its initiation, and who has spent the greater part of his life in the West Indies. This report is well worth careful study as a record of a successful Agricultural Department.—(H. M. Lefroy.)

SOILS.—*Their formation, properties, composition and relation to climate and plant growth in the Humid and Arid regions.* By E. W. Hilgard, PH.D., LL.D. Published by Macmillan & Company. (Pp. 589 and 89 Illustrations). Price 4 dollars (Rs. 12-5-0).

This, the latest work on the subject of soils, will be very readily welcomed by agriculturists generally. The author is well known for his researches in this sphere during the past half century, and the book is a valuable addition to the literature on the subject. Not only is the ground which is commonly dealt with under the generic term "soils" included, but in some respects the usual boundaries are passed. Thus, we have in addition to chapters on the formation of soils, their physical and their chemical properties, much interesting detail regarding the character of plant growth, especially of root development. The dominating characteristics of soil in the humid and the arid regions of the United States are dealt with exhaustively, and so is the nature of alkali land ("Usar" as it is called in India), both being subjects to which the author has devoted many years of study. A discussion of the relative value of different systems of irrigation adds a further feature to this work, which will make it of interest to Indian readers. The various subjects are profusely illustrated throughout. The examples are, naturally, in the main American, but one chapter is devoted to the illustration of the composition of foreign soils.

In dealing with the subject of soil moisture, no mention is made of Mr. Lyman J. Briggs's work, which is probably the most valuable that has been done on this subject, and the movement of the sap of plants is referred to capillarity instead of the osmotic pressure. The information of the bacteriology of soil is also limited. We may, however, confidently recommend the work to Indian students of agriculture.—(J. W. Leather.)

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PROCEEDINGS OF THE TWENTY-SECOND ANNUAL CONVENTION OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.—(United States Department of Agriculture, Bureau of Chemistry, Bulletin No. 99.)

This Bulletin, which appears annually, becomes of more and more interest to the chemist. As is well understood, the chief aim of the

Association is the introduction of new methods of chemical examination of agricultural materials, or the improvements of methods which are already in use. The scope of this work has been much extended of late years, and now includes tea and coffee, alcoholic beverages, insecticides, tannins, vegetable proteids and opium, in addition to the more general subjects of fertilizer control, food standards and the like.—(J. W. Leather .)

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* *

CALCIUM SULPHATE IN AQUEOUS SOLUTIONS.—*A contribution to the study of Alkali deposits.* By F. K. Cameron and J. M. Bell, United States Department of Agriculture, Bureau of Soils, Bulletin No. 33.

The formation of certain salts, and also the proportions in which they are dissolved by water from mixtures of other salts, depend on several factors, such as the nature of these other salts, the temperature and pressure. The most notable work which has been done in this direction is that of Van t' Hoff and his colleagues, who have studied the conditions under which the salts of Stassfurt Beds have been formed. Messrs. Cameron and Bell, recognizing that the nature of salts present in "alkali" lands, and the manner of their possible removal by drainage, must depend on similar conditions, have brought together in this Bulletin the experimental results which have been obtained by various chemists on the solubility of calcium sulphate in the presence of other salts and the nature of the double salts which it forms, this chapter providing a step in the direction of a more accurate knowledge of "alkali" lands. The Bulletin will be found of considerable interest to the chemist, but does not pretend to deal with the 'practical' side of the subject.—(J. W. Leather.)

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* *

THE BLISTER BLIGHT OF TEA. BY H. H. MANN, D.SC., *Scientific Officer to the Indian Tea Association.* Indian Tea Association Bulletin No. 3, 1906.

The most recent of the valuable series of Bulletins issued by the Scientific Department of the Indian Tea Association deals with a blight, which the author describes as being, in its immediate

effects, perhaps the most alarming to a planter of any that attacks the tea bush. It is caused by the fungus *Exobasidium vexans*, which attacks the leaf, producing a blister on the under surface, accompanied by pitting of the upper surface. Later on, the blister turns white and floury, from the production of spores. The blight appears suddenly in April or May, attacking large areas of tea, and quickly destroying the young shoots, ruining the early flushes and reducing the yield in the months of the year when the best tea is made. Heavily pruned tea and the least vigorous bushes suffer most. A curious feature of the disease is that it is confined to the north-eastern corner of Assam, this being in all probability due to the regular spring rainfall experienced there, which, while not always enough to produce an epidemic, is always enough to secure the continued life of the fungus. Spraying with Bordeaux mixture is recommended in the case of nurseries and cut back tea, but has not been effective in the general crop. Leaving any tea unpruned in the districts where the blight occurs is a dangerous practice, for the fungus is able to live on in the unpruned blocks, which become so many centres of infection the following year. In pruning, all diseased leaves should be removed and burned or buried with the prunings. With the exercise of regular care in prevention by these means, and with the knowledge of the circumstances affecting the disease and of the life history of the fungus, given in this Bulletin, we may hope that the disease will be no longer the menace that it has been in the past, though it must always remain a source of anxiety to the tea planters of Upper Assam.—(E. J. Butler.)

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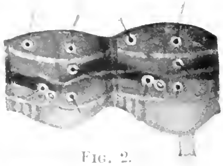

Fig. 2.

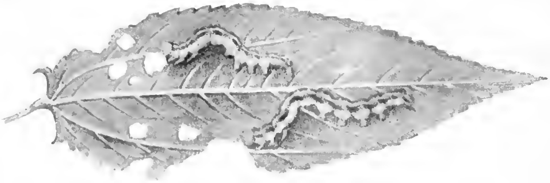

Fig. 3.

Fig. 4.

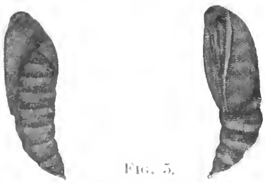

Fig. 5.

Fig. 6.

THE JUTE SEMI LOOPER.

INSECT PESTS OF JUTE.

By H. M. LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist, Agricultural Research Institute, Pusa.

During the past year, attention has been paid to the pests of jute not only in the areas in which it is already cultivated, but in localities where jute is being experimentally grown on a small or large scale. Our knowledge of these pests, though not extensive, has been considerably enlarged and, while there was reason to believe that this crop, grown on a large scale, suffered little from pests, there is now abundant proof that this does not hold good for small areas of jute or for jute grown in new localities.

When a plant is introduced to a new locality, pests are quick to find it and breed in it; they may be very destructive in a small experimental crop, both because of the smallness of the area planted and because the plant may not at first be vigorous. The result is an abundance of destructive insects which do so much harm that the first trials of the crop fail; these trials are no criterion unless the destructive work of pests be also taken into account, and it will be safe to anticipate with jute as with other crops that pests have to be checked by artificial means, which will not necessarily be required in more extended cultivation. Compared with other Indian crops, jute is fairly immune from pests when it is grown on a large scale, and the few mentioned below are probably of little real importance; but they must be checked on all experimental plots, and the descriptions will assist towards their recognition.

A feature of the jute crop is that it affords shelter to very numerous insects, being a luxuriant growing crop, offering shade to many insects at a time when vegetation may be scanty. It follows that an examination of a jute crop in May and June may reveal the presence of very many kinds of insects which are

harmless to the crop itself and are simply sheltering there ; there are also a number of plant-bugs, for instance, which feed there, some on other bugs, some on the sap of the plant, but do no real injury, even the plant-sucking ones not hurting the plant since they move about freely and simply extract a little sap from each shoot. If a list of the insects found on the jute plant were compiled, it would probably be a very long one, but not one in a hundred of these insects would be harmful to it. It remains, therefore, to make certain what species really are injurious and to be able to recognize them and their destructive work.

INDIGO CATERPILLAR. *Caradrina exigua.* Guen.

When jute is quite young, it suffers from caterpillar in just the same way as indigo; this has been fully described in a previous article of this Journal (Vol. I, page 338) on the "Caterpillar Pest of Indigo." This caterpillar also occurs on quite young jute, and in the season of 1906 was destructive in more than one locality. It is likely to occur every few years in any jute-growing place in India, and may be looked for from the time the jute germinates till it is quite six inches high. If it is seen in numbers, and especially on small experimental plots, the egg masses should be collected and the caterpillars gathered in bags by the methods described in the article mentioned above. When jute is grown in large areas, this pest is not likely to cause much damage, but it will be a serious handicap to any experimental plots grown on a small scale to test the value of jute in new localities.

THE JUTE SEMI-LOOPER.

The most characteristic pest of jute is a green caterpillar (*Cosmophila sabulifera* Guen.) that feeds on the apical buds and upper shoot of the growing plant during June, July and August. This is known as a "semi-looper," that is, a caterpillar which has not all the five pairs of suckerfeet properly developed, so that, when it walks, it humps its back into an arch after the fashion of an ordinary looper caterpillar ; it is, however, not a looper, but a near relative of the many destructive leaf-eating caterpillars which attack so many crops in India.

As this pest is of some importance, we may briefly summarize its life-history. The moths emerge from chrysalides that have spent the winter in hibernation, with the first moist warm weather, which depends upon the locality and climate. In Behar this appears to be with a moist east wind in April or May, but in Lower Bengal and the Assam Valley it is probably earlier. If jute is growing, the female lays her eggs on the plants, single eggs being laid chiefly on the under-surface of the young leaves. Each egg is of the usual form, rounded, about one-thirtieth of an inch across, and resembling very closely a tiny drop of water on the leaf. There may be several eggs on a leaf (Plate X, Fig. 1), and a single moth in the insectary laid 155 eggs in the course of twelve days. These eggs hatch after two days, a small green caterpillar emerging, which feeds on the very young leaves and the buds. This little caterpillar has at first only three pairs of suckerfeet, but at the first moult a fourth pair appears and subsequently the fifth, but this last never becomes fully developed. It thus looks like an ordinary caterpillar, but walks like a looper. The caterpillar is green, the head slightly yellow, and each segment bears short hairs on small white-ringed black papillæ (Plate X, Fig. 2). This is quite sufficient as a means of identification, and a caterpillar on jute with this appearance is practically certain to be this pest.

Owing to its colour it is difficult to see, and the bitten leaves reveal it most readily. Holes are eaten in the leaf, as well as portions of the margin, and the leaves at the top of each shoot get a characteristic appearance (Plate X, Fig. 3). The top bud is also eaten, and it is found that caterpillars refuse to feed on any but the youngest and most tender parts of the plant. The caterpillar lives about sixteen days, moulting five times before it is full grown, when it has a length of about $1\frac{1}{2}$ inches: the final moult occurs when it has gone into the soil and it then becomes a chrysalis (Plate X, Fig. 5). In this resting state it remains for a little over a week, the moth then emerging. The moths are not seen by day as they hide away, emerging only at dusk and flying after sunset. The moth is not easy to recognize, and has no

distinctive marks whereby any but an entomologist can readily identify it (Plate X, Fig. 6).

The whole life, from the time the egg is laid till the moth hatches, is about 24 days, the moths then mating and laying eggs. A month is ample time for the whole cycle from egg to egg and, if caterpillars are found destroying the crop, they will recur again a month later as a rule.

There are no regular broods since all the moths do not emerge or lay eggs together, but all stages are found at the same time. This may not always happen, and if a large number of moths lay eggs at the same time, there will naturally be a large brood of caterpillars.

The caterpillars are found on the plant from May onwards to July or later; in small plots there will be enough to seriously defoliate the plants, but in larger areas the pest is destructive, simply because it destroys the top bud and so checks further upward growth, the lateral shoots coming up to take the place of the main shoot. Actually the amount of plant eaten is very small, all the progeny of a single moth having been found to require only one pound of green food for their whole lives; but when this pound of green tissue consists of the apical buds of many plants, there is a considerable diminution in the value of the crop.

Cosmophila sabulifera is a widely distributed insect, which breeds upon wild plants in its normal state; its distribution, summarized by Hampson, is Africa, Aden, India, Ceylon, Burma. It is extremely common in Behar where it attacks jute freely; it is common in Bengal and Assam, has been found on the jute plot at Samalkota (Godavari) Farm, and was reported as extremely destructive to the jute plot at the Dharwar Farm in 1906. It is common in the Punjab and known in the United Provinces. There is every reason to believe that it will be found on every jute plot in the plains.

Unfortunately, the life-history offers no easy method of attack. It is useless to think of destroying the eggs, which are laid singly on the under-surface of the leaves and are very difficult to see

The larvæ do not gather in masses or move about in swarms, and can be attacked only by the tedious hand-picking method, or by spraying the plant with lead arseniate. The pupæ are in the soil and are extremely difficult to find. The moths fly by night and are not easily collected in any number. For experimental plots, we can only advise the sprayer and the free use of lead arseniate in water, at one in sixty. If this is not possible, hand-picking of caterpillars must be resorted to, but on farms at least, if reliable results of trials of jute are to be obtained, one or other method should be adopted. We have frequently urged the importance of using spraying and other methods on farms, and this is a case in point.

There remains one matter in which the importance of good agricultural practice will be manifested. The caterpillar hibernates as a pupa in the soil in any convenient spot near the plant on which it lived; when the crop is cut, the caterpillars are in hiding at the edges of the field; if the crop is simply cut and the stumps allowed to remain in the soil, hibernation is easy; but if the field is ploughed, the margins kept clean, and no untidy or uncultivated borders allowed to remain, the caterpillar or young pupa is turned out by the cultivation and is, in most cases, destroyed. This pest, like so many others, is largely checked by clean cultivation, and it is only helping it to neglect the land on which jute is grown, either by delaying the removal of the stumps and the ploughing of the field, or by permitting the insect to hibernate in grass borders, weedy headlands or any uncultivated strips.

Minor Pests.

The jute semi-looper discussed above is the principal pest of this crop, but a small number of other insects are known to attack it, which may be briefly discussed.

A small green semi-looping caterpillar has been found on the Nagpur Farm, which may prove to be a pest of some importance. This is the larva of a small moth (*Tarache crocata* Guen.), common in India, but not hitherto known as a pest. The

caterpillar is smaller than that described above, greenish-brown in colour and without the white rings to the black spots on the body. Hairy caterpillars of more than one species have been known to attack jute, and the species figured on Plate XV in Vol. I, page 187 of this Journal, is one that feeds on jute in Bengal. We have already discussed these insects, and if hairy caterpillars are abundant, as they often are in the early rains, jute will not escape damage. These caterpillars are not as a rule confined to special plants, as for instance the jute semi-looper above is, but attack nearly all alike. The simple precautions available against these pests must be adopted, *viz.*, hand-picking the caterpillars or spraying, watchfulness for the second attack (which will be heralded by the appearance of the very characteristic moths), and the collection of egg clusters if these are seen when the moths are abundant. With the exception of the species figured, there is some doubt as to the identity of the hairy caterpillars which feed on jute, and we will be glad to receive any specimens that can be sent for identification.

A pest of jute, of which little is yet known, is a very small black weevil (*Apion* sp.), which lays an egg in the axil of the leaf, from which hatches a small white grub which eats into the stem and feeds there, making a small cavity within which it lives. The weevil is very small and not likely to be seen, but the damage caused by the grub may be noticed as the plant bends over, and the discolouration caused by the larva may also be observed.

The genus *Apion* is a very large one, comprising small black weevils whose larvæ live in the stems of plants; this species has not been identified and is probably new, but it is well known in jute-growing tracts, owing to the damaged fibre which is found. It has hitherto been found only in places in Bengal and Assam, but as *Apion* is common all over India, jute-attacking species will probably be found at any place.

We figure the beetle, much enlarged (Fig. 1, page 115), but this is of little value as a guide, as such beetles can be found anywhere. The pest is most easily recognized in the growing plant,

and may be looked for at any time after the plant is well up, its work in the stem not being difficult to discriminate.

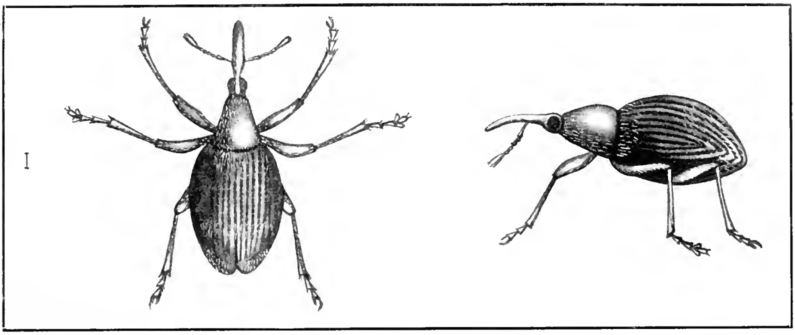

Fig. 1. The Jute Weevil, much magnified.

Unfortunately again, there does not appear to be any practical method of dealing with so small an insect; we draw attention to it rather in the hope that those who are interested will endeavour to ascertain how far damage is done to the jute crop by this pest. There is no means of destroying the pest that is at present possible, but it may be that a trap crop can be found for it if it is in reality a serious pest. We are inclined to think it may prove to be serious since the injury done directly affects the fibre, but the pest has not yet been reported as serious from any part of India.

ARTIFICIAL FERTILIZERS FOR COTTON IN THE CENTRAL PROVINCES.

By D. CLOUSTON, M.A., B.SC.,

Deputy Director of Agriculture, Central Provinces.

THE maximum quantity of farmyard manure that might possibly be made annually in the Central Provinces and Berar by the present faulty methods of conservation in vogue is about 70 mds. ($2\frac{1}{2}$ tons) per head of cattle. There are 10,472,819 cattle in the Provinces and 25,039,428 acres under cultivation, so that the average amount of dung that would be available at that rate amounts to only 29 mds., or 1·05 tons per acre. A very considerable portion of this already inadequate supply of cattle-dung is used as fuel, of which the ash alone reaches the soil, while the manurial value of the rest is very much reduced by the defective methods of conservation practised by the ryot. When the use of cattle-dung as a manure is more highly appreciated, means will doubtless be found of increasing the quantity available and at the same time of improving its quality, but in order to supplement the present supply, experiments have of late years been carried out at several agricultural stations throughout India in order to test the effectiveness of artificial fertilizers as crop-producers, in anticipation of their being used to supplement the natural manure of the farm.

The three substances most valued in artificial manures are nitrogen, phosphates and potash. Some manures contain only one of these; for instance, nitrate of soda and sulphate of ammonia contain only nitrogen, superphosphate contains only phosphate, kainit, sulphate and muriate of potash contain only potash. To apply these manures economically, it is necessary, in the first place, to ascertain the manurial requirements of the

soil, and then to apply only that in which the soil is defective. This is not always done ; farmers even in Europe and America, who are otherwise intelligent and practical, often apply their manures in a haphazard fashion.

All manurial experiments carried out on the black-cotton soil of the Nagpur Experiment Station go to prove that for that particular soil an artificial manure rich in nitrogen is the only one that can be profitably applied. Repeated trials with saltpetre have conclusively proved that it is a profitable fertilizer for cereals, if there be a sufficiency of moisture in the soil to dissolve it. When applied to the rabi crops, its effectiveness is largely dependent on the cold-weather rainfall. The chief objection to the use of saltpetre is the large variation in the percentage of nitrogen in different samples, and a low percentage of nitrogen means a higher percentage of other substances that are often noxious to the growth of the plant. Samples of nitrate of soda and sulphate of ammonia vary much less in composition ; they should contain about 15½ per cent. and 20 per cent. of nitrogen respectively.

An interesting series of experiments with these manures was started last year at the Nagpur Station, which was designed to test the manurial requirements of cotton on second class black-cotton soil. Nitrate of soda, superphosphate and sulphate of potash were the manures applied. Eight plots, each one-tenth of an acre, were used. The first six plots were very even to start with, and had given nearly equal outturns of cotton the previous year. Plots VII and VIII, however, had been cropped with wheat in that year ; in other respects they are very similar to the first six. The variation in the previous crop, however, gave the last two plots a decided advantage : otherwise, the whole area is very even and it may reasonably be expected that future results will show no marked discrepancies. The greatest possible care was taken to secure an equal distribution of plants on all the plots, which is absolutely necessary if accurate results are wanted. In the present experiment, on counting the plants on each plot after the usual thinning had been completed, the

number on one plot was found to exceed that on another by 480 plants or at the rate of 4,800 per acre. Needless to say this unequal distribution of plants is an important factor in determining the yield, and would have gone far to falsify the results of an experiment in which the comparative effectiveness of the manure employed was the only factor to be considered. Taking the most sparsely cropped plot as the standard, the number of plants on each of the other plots was reduced to that of the standard plot. The number left on each plot was 1,846 or at the rate of 18,460 per acre. The manures were applied at the rate of 130 lbs. of nitrate of soda, 65 lbs. of sulphate of potash, and 260 lbs. of superphosphate per acre; these supplied 20 lbs. nitrogen, 35 lbs. potash, and 50 lbs. of phosphoric acid respectively.

The outturn of seed-cotton in lbs. per acre, and the gain from the use of the manures employed, are shown below.

Plot.	Manure applied.	Outturn in lbs. seed-cotton per acre.	Quality of cotton.	Length of lint.	Increase and Decrease in lbs. due to manure.	Value of increase and decrease per acre.	Cost of manure per acre.	Gain and Loss.
						Rs. A. P.	Rs. A. P.	Rs. A. P.
1	Nitrate of Soda, Superphosphate and Potash ...	870	Fine ..	5/8"	+360	+35 9 0	30 7 0	+ 5 2 0
2	Nit. and Super. ..	800	Coarse ..	1/2"	+290	+28 9 0	25 5 0	+ 3 4 0
3	Nit. and Pot. ...	800	Fine .	9/16"	+290	+28 9 0	20 3 0	+ 8 6 0
4	Nit.	760	Coarse ...	1/2"	+250	+24 10 0	15 1 0	+ 9 9 0
5	Pot. and Super. ..	480	Fine ...	1/2"	− 30	− 3 0 0	15 6 0	− 18 6 0
6	Super.... ..	390	Very short	7/16"	− 120	− 12 0 0	10 4 0	− 22 4 0
7	Pot.	520	Fine ...	3/4"	+ 10	+ 1 0 0	5 2 0	− 4 2 0
8	No manure ...	510	Fine ...	1/2"	......	......	......	....

It is generally quite unsafe to draw conclusions from the outturns of a single year's crop, but the results are so striking as to justify their careful consideration. The outturns show that the nitrogenous fertilizer is the most important one for cotton on this particular black-cotton soil, a result quite in accord with other manurial tests. When superphosphate and potash are applied along with it, there is a considerable gain in the outturn, but the value of the increase due to the latter two fertilizers is not sufficient to cover their cost. When phosphate is applied without the nitrate, it would seem that it tends to diminish the

yield. This is apparently due to the fact that the crop on plots V and VI to which it was applied without nitrate matured very early, after which the leaves of the plants thereon showed signs of shrivelling up, while the first four plots were still green and flowering. The yield was thus materially affected by the shortening of the growing period of the crop. The plants on the first four plots were conspicuous by the dark green colour of their leaves. They grew, too, to a much greater size, and produced a much larger number of bolls than those of the remaining four plots.

The results are in accord with those of the Ville Experiments carried out some years ago at the same station. The preliminary conclusions to be drawn from them are :—(1) that nitrogen alone is deficient in this particular soil, (2) that the cotton crop is not materially benefited by applications of potash or phosphate without nitrogen, (3) that when potash and phosphate are applied along with nitrogen, the value of the increase is not sufficient to cover their cost, (4) that potash and phosphate, applied together or singly without nitrogen, result in a dead loss.

From an economic point of view, nitrate of soda is a highly profitable manure. The prices as stated include freight charges from Calcutta on 1 cwt. lots. If purchased in bulk, the cost would be considerably less, and the profits proportionately greater.

In America where artificial manures are much used, it is said that nitrate of soda increases the outturn but tends to produce a coarseness of staple. A sample of seed cotton from each of the eight plots was sent to the Manager of the Empress Mills, who kindly supplied us with the facts and figures shown in columns 4 and 5 of the statement above. It will be seen that the coarseness of fibre would seem to be due rather to the absence of potash than to the presence of nitrate of soda. The cotton grown on all four plots to which potash was applied is classed as fine. This may be taken as something more than a coincidence, corroborating as it does the results of American experiments which prove that potash manures improve the quality of the lint. The lint of the cotton

of Plot VI manured with phosphate was the shortest of all, but whether this was directly due to the fertilizer employed or to the general poorness of the crop in the absence of other manures, it is impossible to decide from one year's results. It may be that the shortening of the growing period due to the phosphate accounts for it. When phosphate is applied along with potash as on Plot V, the lint attains an average length. Suffice it to say at present that the quality of the lint depends more on the potash than on the other two manures, and that the market value of the coarse staple *Jari* cotton grown in these Provinces is not likely to be materially affected by the nature of the manures applied.

The great disadvantage in continuing to use a forcing manure such as nitrate of soda is the danger of general soil-exhaustion. The nitrate supplies the necessary nitrogen, but the greatly increased outturn thus produced makes excessive demands on the potash and phosphatic salts in the soil. If these are not added in some form along with the nitrate, the soil's supply of them will sooner or later become defective. This error can be avoided by using a general manure along with this nitrogenous fertilizer. Cattle-dung is the best general manure obtainable. The ryot should be at least able to apply it to his cotton crop at the rate of one ton per acre. The ryot who will supplement this natural fertilizer by a top dressing of about 1 md. (82 lbs.) of nitrate of soda, immediately after the plants are thinned out, will find that his profits are enormously increased thereby.

If nitrate of soda is applied alone, about 1 cwt. (112 lbs.) would be an economical dressing. To give its full effect, it should be sprinkled round the stem of the plant immediately after the first thinning, so that it may be dissolved and washed down to the roots by the first shower of rain. As the growth of the plants will be greatly increased, there should be a distance of 15 inches between successive plants in a row. If the rows are 15 inches apart, there will then be 27,880 plants per acre. A quantity of nitrate of soda equal to that which will lie on a rupee should then be applied to each plant.

Other fertilizers that should do almost equally as well as nitrate of soda as a manure for cotton are sulphate of ammonia and saltpetre. If sulphate of ammonia is used, it should be drilled in with the seed, as it is slower in action than nitrate of soda. Refined saltpetre may be used in exactly the same way as nitrate of soda and should give equally good results as long as it is applied at a rate at which it gives the same amount of nitrogen per acre. But the quality of the saltpetre commonly sold in India is often very impure and generally contains a low percentage of nitrogen. Before deciding on the kind of nitrogenous fertilizer to use, the cultivator should ascertain the percentage of nitrogen in each and its price per unit. If in the price lists the nitrogen is expressed as ammonia, the percentage of nitrogen can be obtained by multiplying the ammonia percentage by $\frac{14}{17}$, as 17 lbs. of ammonia always contain exactly 14 lbs. of nitrogen. The tabulated statement below shows the price per maund including freight charges at which these fertilizers are being offered this year by well-known firms.

	Cost at Nagpur.		Per cent. of Nitrogen.	Price per lb. of Nitrogen.	
	Rs.	A.		As.	P.
Crude Saltpetre	6	1	8·8	13	8
Nitrate of Soda	9	10	15·5	12	5
Sulphate of Ammonia	9	8	13 5	14	0

The sulphate of ammonia is of an exceptionally poor quality. The nitrate of soda is not only the cheapest of the three per unit of nitrogen, but the value of its nitrogen per unit is more than that of ammonium sulphate. There is reason to believe, however, that if refined saltpetre be obtained instead of the commonly used crude material, it should give even more profitable outturns than the nitrate of soda. The two will be tried side by side this year.

Intending purchasers should note carefully that nitrate of soda should contain not less than 15 per cent. of nitrogen, and a guarantee to that effect should always be obtained before a purchase is made. As nitrate of soda is a very soluble salt, care should be

taken to keep it perfectly dry if it is to be stored during the rains. If thrown on a damp floor or exposed to the rain in any way, a considerable part of it will be dissolved and lost. It would be advisable, therefore, for cultivators who do not possess good facilities for storage not to store the manure in their houses, but to get it shortly before it is to be applied; but orders should be booked as early as possible. It is also advisable to purchase only as much as is required to manure two or three acres the first year; larger areas can be tried as soon as the use of the manure is more clearly understood and proved to be generally successful.

SOUTH INDIAN AGRICULTURAL FOLKLORE.

By C. BENSON, M.R.A.C.,

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"The ploughers are the linch-pin of the world; they bear them up who other works perform, too weak its toils to share." Thus Dr. Pope has translated a couplet from the celebrated *Kurál* of the Tamil poet Tiruvalluvar. Alongside this, a saying current amongst the Telugu people of Southern India may also be quoted, "Better the gifts of the earth than the rewards of the powerful."

Many similar sayings might be given to show the estimation in which the practice of agriculture, in both its branches, is held amongst the people of that part of India, to whose wealth of lore on agricultural matters it is my object to draw attention. A study of such 'concentrated essence of the wisdom and experience of ages', even though in parts it be encrusted with the dust and cobwebs of superstition and age, cannot fail to lead to a more than useful understanding of the attitude of the people towards the art itself and the conditions under which it is carried on. Some twenty years ago, I commenced to collect such sayings, and later, with the help of the District Officers, many were brought together. which appeared in two Bulletins published by the Madras Agricultural Department under my editorship. It is my hope that these sayings may not be lost sight of and that the work of collecting more may fall into other and more competent hands now that I have left the country, and I also trust that similar work may be undertaken in other provinces; for, not only are such collections interesting in themselves, but they will serve as a most useful guide to the newcomer from the West in

his study of oriental conditions and practice. Moreover, at the very first, he has to grasp the fact that his presence is justifiable only by his aim —" if the ryot prospers, the King (State) will prosper"—whilst he must remember the genesis of the Agricultural Departments in India when he reads that " crop extinguishes famine, as fire destroys locusts."

One of the most strongly held ideas of the ryot is that, as the Tamil saying has it, " a Vellalan is a proper husbandman ", or as it is in Telugu " only a Reddi can cultivate the land, even though he has to drink for every clod turned over", thus emphasizing the view that only those who are cultivators by birth are really competent to undertake the practice. At the same time, scorn is poured on other members of the community in connection with this profession, for at one end we are told that " the harvest of the Pariah never reaches home ", he being so improvident; and at the other that " a Brahman's husbandry is of no account ;" the latter view being insisted on still more strongly in the saying that " farming by a Brahman ends in the loss of his cattle, and education to a farmer is waste of money ", the second part of the last quotation being interesting as an echo of ideas that have travelled the world in past days but now fortunately giving way to more modern ideas. Again, it is held that " the merchant has a natural aversion to agriculture", which may perhaps be explained by other proverbs which shew that " keeping accounts is possible in trade, but not in agriculture," and that " parsimony is an inveterate enemy to agriculture." The failure of the Brahman may be explained in the saying that " even when a Brahman becomes poor, he will not touch the plough " and that " cultivation by a Brahman yields only wages to the labourer "; whilst it is held that only " one that can plough should touch the earth ", that " success in agriculture depends upon strength ", and that " crop is obtained after ten (kinds of labour)." It is to be hoped, however, seeing how large a proportion of the young men available for agricultural studies nowadays is composed of Brahmans, that in this respect a change has come over them ; and yet the point of view of the hereditary cultivator

must not be lost sight of, for the usefulness of the departmental agents is hampered by these traditional views and ideas, and the Brahman subordinate is handicapped heavily thereby. To overcome this handicap, he must show genuinely that he appreciates how "the field-ridge is the pillow, and the straw the mattress (of the ryot)" and that "a crop is lost for want of looking after, a horse for want of riding, and a debt for want of asking;" or again that "husbandry not carried on by one's own men, and a field not ploughed by its owner, go to waste." He must also remember that "if you go abroad during the ploughing season, you need not look for a sickle at harvest," that "the more you inspect your fields, the more you gain," that you must "visit your fields morning and evening," and should ever hold before you the question "Will crops uncared for by the owner prosper?"

Besides thus insisting on the necessity for personal attention to the work and the advantage of doing it with our own hands, the men of the south recognize clearly the advantage of experience, for they say that "farming by youths does not provide enough for one meal," but the point is not laboured. Another apposite saying is that "without capital, how is it possible to raise crop in the field?" and again "it is miserable to farm without grain to eat and without implements of one's own," whilst "he who cultivates his land by borrowing is like a man who lets go of the tree he is climbing;" but "he that has seeds and cattle should take to farming," though "miserable is the life of a farmer who has sold his cart and bullocks," and "the death of the plough cattle and the death of one's wife are equal calamities," as "cultivation without bullocks is like journeying without provisions," or, to put it otherwise, "the prosperity of the ryot depends on his cattle." And, finally, the whole situation is summed up when it is said that "if the ryot is poor, the land is poor." Draught cattle, a few low-priced implements and tools, and the necessary seed constitute the essentials to enable the ryot to commence cultivation provided he has the land, though often even he can and does begin with a single bullock, notwithstanding the

fact that "cultivation with one ox is like a pain in one leg;" for the poorer members of the community get over the difficulty by mutual co-operation, and show in practice that "there is nothing like clubbing of ryots (in farming)." At the same time they recognize the difficulties of the single-handed man, for it is said that "farming is easy if the family consists of many persons; if of one, it is torture," and yet the risks attending the undertaking of farming on a large scale are quaintly summarized in the remark of a ryot in an interview with a 'sky-clad' Jain image, when he said "Possessed of ten yoke of oxen I lost the ploughshare; how many yoke did you possess before you lost your waistcloth?"

This aspect of the prospects of the cultivator is abundantly illustrated in these common sayings, though the total result is, perhaps, most aptly summarized in that which says "cultivation is like a stone in a madman's hand," or again in the saying that "partiality is characteristic of a mother and of the earth," for throughout the South it is said, in some form or other, that—

"If the ploughman count the cost,
His ploughshare ever will be lost."

Or, in more moderation, that "agriculture brings no more than bread"; and thus it follows that "if you can weep, take to agriculture," though it is added "though you be weeping, be always ploughing" and "do not abandon cultivation, even though you get back the seed only."

Among those sayings which advise on the selection of land, whilst it is said that "a foot of lucky land is enough", the advice is often of worldwide application, for the advantages of concentration and accessibility are clearly shown in "secure land in one block, even though it be inferior" and "though of inferior quality, the field should be near (the village);" but still "the cultivator of a field close to the village loses its produce (by pilfering)" and "the field close to a village site will always suffer from the 'evil-eye'," or, again, "the crop in the backyard is crop for thieves." The ryot's holdings are, however, far too often made up of scattered parcels, and this fact lends point to the saying "do not fail to

acquire an adjoining field nor a plot of land near your house" ; whilst the disadvantages of holding land in more than one village are shown in the sayings "a bride of the same village and land in another village are bad" and "a washerman's business in another village and tilling land in another village are not profitable," for "to cultivate in two different villages or to marry two wives will lead to ruin." Again, the wisdom of the saying that "it is better to cultivate a small piece of fertile land than a large tract of poor soil" comes home at once to all, and this is enforced by stating that "(rich) land is better than (good) seed," or that "good soil yields good crop."

When it comes to more particular selection, it is necessary to remember the two divisions of cultivation in Southern India—that of the 'dry' land or the land dependent on the rainfall and that of the 'wet' land which is irrigated by flow ; whilst in addition to these two great groups is the 'garden' land irrigated by lift, mainly from wells. And in referring to these, we find certain natural contradictions owing to the different schools of thought that prevail in different parts. Thus "dry land yields one crop, wet land two (in a year)" and "is it a King's income or that from wet land which is the greater?" or "those who cultivate wet land and those who travel in a palanquin are alike"— they grow fat ; but others will say "no one ever became rich by wet cultivation nor poor by dry cultivation," and "no one ever became impoverished by the cultivation of dry land as no one ever prospered by doing evil ;" and yet others will add "those who cultivate dry land and those who drink toddy are alike," and yet it may be responded that "dry land and a widowed girl should never be abandoned."

The form of cultivation called 'garden' is not nearly so generally practised amongst the Telugus as amongst the Tamils, and the only saying of the former with which I am familiar is that "no one ever prospered by cultivation under wells, and no one ever became impoverished by dry cultivation" which is only very locally correct and is not acted on : for, in parts, the Telugu people cultivate extensively under wells and that cultivation is

some of the best to be found in South India. The Tamil saying "let the man without work keep a garden" is plain and to the point, as also is "if you take care of the well, the well will take care of your stomach" and "fill up the well and you starve;" whilst "in a used well, the water flows freely; in an unused one, it will stink" is also as obvious as that "water and a thief should be secured," for "crops without water are like un-oiled hair."

Throughout the South, the dry land is of much the greatest importance, however, and on its cultivation a much larger proportion of the people depends than on the wet land, though the owners of the latter are more often heard. Of this class of land, as indeed of all land, it is said that "the stubble shows the produce of the field," but the futility of depending on 'colour' alone as an indication of the quality of land is shown in the saying that "the soil under a fowl's foot bears ten million colours," that is, every inch of land varies in colour: and yet the people who recognize this go on to say that "the crops raised on red soils yield but a day's food;" but more to the point is the information that "no one thrives by tilling sandy soil, and no one is ruined by tilling clay" or the advice to "plough only the land which is free from stones, and have dealings only with the man who keeps his word": or "*turra* (poor sandy loam) hungers after manure as a Brahman after *ghi* (butter)" and "the farming of *baraka* (an inferior gravelly soil) is as uncertain as the friendship of a Muhammedan." Then again the Tamils say "though but a *kani* (1·2 acres), choose *karisal* (black cotton soil)" or that as "*kalli* (Euphorbia) makes the best fence, *karisal* is the best of soils." But again, in judging the quality of land, the aid of an examination of the natural herbage is fully recognized, and this opens up an interesting field for useful botanical investigation; thus it is pointed out that "the soil in which *karandai* (Sphœranthus indicus) grows is the best; that where *kolinji* (Tephrosia purpurea) grows is middling" and that "wet land on which *árai* (Marsilea quadrifolia); red gravelly soil on which *hariáli* (Cynodon dactylon); and black cotton soil on which *kórai* (Cyperus bulbosus) grows (are the best of their kind)," and another

saying puts it "wet land in which *árai* grows and dry land in which *hariáli* grows are good."

Most of the sayings quoted above, it will be noticed, apply to the dry land, but those referring to the wet land allude more especially to the situation of such land and its facilities for irrigation, and it must be remembered that this irrigation is principally from reservoirs, which leads to the saying that "if the tank leaks the village goes to ruin" or, as it is otherwise put, "either a wife from a wealthy family, or a big tank to irrigate the field is necessary." In the selection of wet land, it should be remembered that "high ground near the tank bund is better than low ground at the end of the channel" or that "either a field under the sluice or a husband who can speak fluently is necessary," and that "the man possessing land near the irrigation source will, even with a slight effort, realize more than one who works hard on his land at a distance from it." Again it is recognized that "by wet land is meant paddy cultivation; but the cultivation of wet land is often attended with risk," and that "when the wet land becomes poor, the ryot becomes poor;" whilst also "ridges (field bunds) are as important a protection to (paddy) fields as secrecy to a family" and "bunds to a field and unity amongst villagers are essential:" and yet, while recognizing the value of these bunds for retaining the water, it is said that "a (paddy) field with drainage channels and branded cattle are useful"—in this recognizing the truth of the contention that it is not sufficient merely to bring water on to the land but that provision for draining it off must be made also, for "the effect of water in a field or a blow on one's body cannot be overlooked." Finally, the advice given in these sayings as to the selection of land is summarized in two which shew that "new dry land and old wet land (are good)," and that you should choose "wet land near the sluice and dry land near the hill," whilst "though liable to flooding, the low land will be productive."

The Tamils also have a number of sayings referring to the necessity for close attention to the field-ridges or small bunds

between the plots into which it is customary to divide the paddy fields; thus it is said that "the higher the field-ridge the more the paddy; the more the paddy the richer the husbandman; the richer the husbandman the richer the country; the richer the country the stronger the King." And this may be explained by a quotation from the *Kánchi-Puranám* to the effect that "after the water which is abundantly confined within the bunds has deposited its silt and becomes clear, the ryots get rid of the whole by drainage channels." Again it is said that "to trim the field-ridge and to apply black to the eye are alike good" and that "the narrower the field-ridge, the fuller the stomach," in allusion to the wasteful practice of some localities of allowing these bunds to become broad and wasting land thereby. Also the ryot is urged to "trim the field-ridge as clean as a butcher cuts the neck of a sheep," and again leaks must be prevented for "if there be a hole in the field-ridge, you will lose one kotah (400-500lb.) of grain."

With regard to other details of laying out land for cultivation, the sayings of the people are few, but in Telugu there is one to show that "a field without a tree is like a village without relatives," and amongst some of the Tamils, the advisability of fencing land is very strongly held and in a few localities the practice of fencing is general. These go so far as to say that "partially fenced land is no land; tillage with a single pair of cattle is no tillage" and "an unenclosed field and bullocks ploughing without a rest are alike," for "a hedge protects a crop as a man's kin assists him" and "young plants not protected by a fence and an oil-monger not working his mill cannot thrive;" and, looking at the hedges from another point of view, it is said that "a fence shuts out rinderpest," the worst plague the ryot has to fear; for "the man without cattle fears the heavy rain no more than does a single man the battle-field," and one of the most desirable improvements in Indian agriculture would be an extension of this practice of enclosure and the abandonment of dependence on the common grazing grounds on which the cattle of the country at present depend almost entirely.

One of the commonest ways of carrying on cultivation, especially in the case of Brahmans and where rich irrigated land is concerned, is to give it out on shares, or as it is called in Tamil on *váram*, and of this system it is said that "giving land on *váram* is a cause of disgust; the renter is always a thief," whilst "the death of the cattle matters nothing to the tenant nor the death of the child to its step-mother;" but on the other side, it is said that. "he who pays *váram* by purchasing grain and he who cultivates for *váram* will not prosper;" and, as is obvious, "partnership in the field ends with threshing the corn," and in this, the fleeting interest of the tenant, lies the root of the evil of the practice.

With regard to the management of labour, there is a homely saying that, "a hasty man will lose his crops, and a beggar his wife," and another urges the employer to "be cheerful whilst ploughing, but severe at harvest;" and yet one wonders if it is always true that "the master cheats the labourer of his wages; the coolie, the master, by loitering," but it seems to be a well observed fact that "a labourer who is paid in kind at harvest is never out of debt," for he is always under advances to his master.

To enter at all fully on the vast number of sayings, current with reference to the weather and rainfall, would necessitate a great expansion of this article, and at the same time involve a discussion of the usual distribution of the rainfall of the areas in which the sayings are current, which I have already attempted in another published paper, so that only the briefest allusions to such sayings can be made here. The essential need for rain is clear, for "nothing can be done without rain," and "the crop that is not rained upon and the child that does not see its mother's face will not live," but the extreme uncertainty of the rainfall is described when it is said that "when rain may come or life may go, no one knows." Still "unseasonable rain is like untimely food," or to put it otherwise "unseasonable rain is as useless as *àriké* (Paspalum scrobiculatum) as a food." Some of the sayings are no doubt records of observed facts, some are

merely popular beliefs as well founded as the belief in the influence of the moon on the weather. A few that are particularly apposite may, however, be quoted; thus, it is advised that "if the clouds disperse (in the rainy season), lend your stored seeds at interest," and "if the south wind blows in the rainy season, sell your bullocks and buy sheep," for "a south wind in *Adi* (July-August) is disastrous;" or again "rain in *Magham* (January-February) is like a woman without a husband," and "if it rains in *Palgunam* (February-March), it will spoil the whole." The most interesting of the sayings bearing on this subject are, however, those which allude to the 27 astral periods into which the year is divided; these show that "if it rain in *Révati* (early April), all crops will yield well," but "if there be rain in *Aswani* (late April) every crop will be lost;" whilst "rain in *Bharani* (early May), grain in *Tharani* (the earth)." Then again "rain in *Mrugsira* (early June) will make even an old bullock bellow." The references to these periods are, however, more common in the sayings of the Telugu people than in those of the Tamils, and it will suffice, in order to show their nature, to quote but a few more. Thus, "no rain in *Makha* (late August), and *Pubha* (early September), forebodes severe famine says one; but another answers, wait till *Uttara* (late September), and, if the rains fail, then be off bag and baggage; but, says a third, why? *Hasta* is not yet over! and if *Hasta* (early October) also fails, let us all be off! but again, say the flocks, '*Hasta* is the season of heavy rains; Oh! shepherds! fold us on the rocks or we shall die!'"

The positions of certain of the stars, the moon and its appearances, rainbows and how they look, redness of the sky at morn and evening, lightning, as for instance, in "the more the lightning, the heavier the rain," and "if there be lightning in the south-west, the bullock laughs," or "if lightning flashes in the west, not even a pig would approach the water-course;" thunder and especially the indications of unusual thunder, as for instance, "if it thunders in *Arpisi* (October-November), grass will grow at the bottom of the wells," whilst, quaintly enough, it is a general belief that, "as a dry cow bellows most, so a rainless cloud

thunders most," and "the labours of a grumbler and thunder before rain will end in nothing." So too the swarming of white ants and the habits of other insects when rain is about, as well as the manner in which animals behave at such times, are all recorded in these sayings, such as "rain ceases when winged white ants appear;" "if the dragon-fly flies low, it will rain without fail;" "if cattle look bewildered towards the sky, it will rain;" "if the sheep flock together, there will be heavy rain."

Again the prognostics of the flowering of plants, etc., are fully referred to amongst the Telugu sayings, and it would be an interesting study to follow them up. In both languages, it is said that "if the *Jamun* (Eugenia jambos) fruits well, the country will prosper;" but it is peculiar that, whilst the Telugu says "mangoes for a good season, tamarinds for a bad one," the Tamil has it, "tamarinds in a good season; mangoes in a bad;" but the former saying, which is current in the Kurnool district, is contradicted by another, current in North Arcot, "mangoes foretell famine, rose-apples (*Jamun*) a good season," and in the latter district Tamil is spoken as well as Telugu. But perhaps the most forcible saying of this class is, "though a Brahman's word may fail, the flowering of the *margosa* (Melia azadirachta) will invariably foretell a good harvest."

When matters of actual practice are alluded to, it is well to remember that "the cultivator's way and the sheep's way are alike," though unfortunately in practice the ryot does not follow the sayings that embody the wisdom of his ancestors literally and generally; thus, it is said that "yield is proportionate to tillage as happiness is to wisdom," and "a well-tilled field and a man who has friends (to assist him) will never come to grief," whilst "if the share wears out, the granaries will burst with grain," or "if land is in good tilth, it will yield even to a Pariah," though "the harvest of the Pariah never reaches home." Again the couplet of Trivalluvar may be quoted:—

"Reduce your soil to that dry state, when ounce is quarter ounce's weight;

"Without one handful of manure, abundant crops you thus secure."

And—

"To cast manure is better than to plough;

"Weed well; to guard is more than watering now."

But the necessity for tillage is clearly shown in the homely metaphor "untilled land and curry not seasoned with pepper are useless," whilst it is added that "if the soil be ploughed to the consistency of butter, the yield will be a mountain heap," "a mellow furrow will retain moisture," and "will not any crop flourish in well-ploughed soil?" Then again, "ploughing can do what manuring cannot;" "land ploughed seven times needs no manure," and "defective tillage cannot be made up for by manuring." Then in the saying, "Better plough six times in a hundred days than a hundred times in six days," the idea that "soil ploughed and exposed to the air will be benefited" is shown; whilst advice is given to "plough for depth instead of breadth," for "land deeply ploughed retains moisture," or again that "deep ploughing is better than sheep-folding," though "the tread of the sheep *is* enough," a saying that has its parallel in the Spanish proverb that says "the feet of the sheep are golden." But "ploughing cools the soil" and "the coolness produced by tillage is the best coolness, as a mother's milk is the best milk." In the Telugu saying that "under the Magili system of cultivation, even a Madiga (Pariah) will grow good crops", there is a reference to a system that may be compared with the autumn ploughing of the English farmer, and it is to be regretted that the practice is not a general one, though its value is in a way recognized in the Tamil saying—"If the soil be allowed to dry after ploughing, the yield of grain will be doubled."

With regard to the performance of tillage, "those who delay their ploughing will want for gruel," but "be sure of rain and then plough," and "plough when the field is moist;" so also "only when the ploughshare is sharpened will the plough work," and "even for the eighth ploughing, a wooden share will

not do," whilst "if the ploughs are made of *margosa* (soft) wood, the advantage of a good season and good soil will be lost." When the saying, "plough with the pointed edge and level with the broad face," is read, the peculiar form of the Indian plough must be remembered, whilst the manner in which it acts explains why "wet land requires seven ploughings and dry land four." Still it is necessary to "adapt the share to the ploughing," and it is well to "yoke strong bullocks to the leading plough," and "do not beat on the head the bullocks which draw the first plough," whilst "ploughing with lazy bullocks is bad." And, still remembering the manner in which ploughing is carried on in India, the situation is summed up in the saying that "a ryot with a single pair of bullocks is ruined by ploughing continuously; one who has four pairs, by frequent stoppages; and one who has ten pairs, by looking on."

In his saying—"Good tillage prevents disease; leaf manure gives luxuriance; cattle manure increases the yield"—the Telugu man alludes to his three great mainstays, and he adds "apply cattle manure to dry land and leaf manure to wet land," whilst further he says that "a field without manure is as useless as a cow without her calf" (she will not let down her milk), and "the well-manured field and a well-managed daughter-in-law will not turn out badly." The value he puts on sheep-folding has already been mentioned, but he also says "when you ask a shepherd where grain is to be had, he will say in the dung dropped by his sheep." As to leaf manure, he asks the question,—"Did you apply *Vémpuli* (Tephrosia purpurea) with its roots and *Kánuga* (Pongamia glabra) with its fruits?"—or quotes the reproach—"You never applied *Tangédu* (Cassia auriculata) with its flowers and *Vémpuli* with its fruits that you should expect good crops from me!!" says the field. He also holds that "*Margosa* oilcake is equal to cattle manure." These sayings cover almost the whole sources of manure supply that have been available to the ryot, and parallel quotations might be quoted from amongst the Tamil collection where there is one showing that "it is manure and not one's knowledge that makes plants grow," and another

that "crop without manure is as worthless as a flower without scent," whilst it is recognized that "as the rubbish heap rises, the ryot prospers." A Tamil saying points out that "sheep manure serves in the first, cattle manure in the second year," and another that "sheep dung lasts one year, and that of cattle for six," whilst the value of the former is tersely put in "a field untrodden by sheep and a maid without a husband are useless," for "untrodden by sheep, no land will produce." Again he says, "sheep-folding is good for one crop, *áválai* (Cassia auriculata) for three" and "sheep dung has effect on the plant; *avarai* on the grain of paddy," whilst it is held that "early crops require sheep-folding; and late crops (of longer growth) leaf-manure." In the saying that "*Páráchéri* manure gives a better yield than any other," the ryot notes the fact that the manure from villages of flesh-eaters, which may contain a good deal of animal refuse, is extremely rich; whilst "one kind of soil is manure to another" recognizes the benefit of mixing soils, and is perhaps at the root of the practice of carting out tank-silt as a manure. The number of sayings on this branch of the subject is not great, but the quotations made show that they are to the point, and they cannot be left with better advice than "plough after manuring," a saying of almost universal application.

The sayings quoted above deal most comprehensively with the preparation of the land for crops, and there are many which refer specifically to the necessity for paying careful attention to the selection of the seed and the time and manner of sowing it. Thus in Telugu it is said, "give gifts to the deserving, and so select the seed for the soil," and in Tamil, "seed suitable to the land is like a girl suitable to a family;" or, as another saying puts it,—

"Alms to those who do deserve; seed for land that it will serve;

Girl for wife you should bestow, in family that you do know."

But what is insisted on in the strongest manner is that the sowing should be performed at the proper time; thus "if sown

in proper time, though it be in a bush, there will be a good yield," whilst "crops out of season are like an old man's children," and "if the seed time be missed, not even the dunghill can grow a crop," or again "if you sow in proper season, you need not borrow." As to what are the proper seasons for sowing, there is a number of sayings, but as they are of more or less local interest only, I will not allude to them here. That special days are lucky for sowing, the sayings show, and the Tamils urge that sowings should be made on Fridays, whilst as regards paddy they say that "the sowing of paddy should not be continued over a Saturday nor a Tuesday" and that "paddy should not be sown on a new-moon day, nor during *Kathri* (when the dog-star prevails)." The Telugus also say, in allusion to the practice of preparing seed-paddy for sowing, "no seed should be sprouted on a Tuesday" and the Tamils "do not plant on a Tuesday, or reap on a Wednesday," whilst generally they urge that reaping should be done on a Thursday or a Saturday.

The importance of early sowing is insisted on in "early sowing and a young wife are good" and in "till your field at the proper season and sow your seed with a timely rainfall," whilst "when timely rainfall fails, the assessment (*kist*) will have to be paid for nothing," or again in "early sowing is best," and "be foremost in cultivation and hindmost in an army." But the advice is also given "do not sow when it is raining" and "sowing land when it is very wet, farming in two villages, and having two wives, are injurious," though "if the ploughed field dries before it is sown, the cost of cultivation cannot be recouped" and "a sowing in dry soil and the offspring of a concubine are alike.'

On the question of thick and thin sowing the Tamils and Telugus do not agree: the former say that "a thick crop and a numerous army are the best;" the latter that "a thin crop yields well, a thick crop looks well" and, speaking generally, an observance of these sayings appears to govern their practice. The latter explain that "by thin sowing, the barns are filled; by thick sowing, the stacks will swell." The former add, however, "sow thick; plough out the thick spots," for they too hold that

"people must live close together, but plants must be wide apart." With the Tamils, sowing is practically always done broadcast; with the Telugus with a drill, and the latter use a very minute amount of seed.

"If one seed be sown, will plants of another kind grow?" is a sententious question that may be asked anywhere in the South, for it is held that "as is the seed so is the plant," or, as it is otherwise put—"if the *moduga* (Butea frondosa) is sown, will it bear *sampangi* (Michelia champaca) flowers?" But these sayings seem to inculcate the doctrine of "like produces like" more than anything else, though they are not without interest in themselves.

When a field has been sown, "rain before the seed sprouts is as painful to see as the face of an enemy," for, if rain falls soon after the land has been sown it often causes serious damage, and it is to overcome this drawback in part that the Telugus perform an operation which they term the *paitsál párádám*, or a harrowing, performed usually three days after sowing, to break up and loosen the surface and to hasten the sprouting. Of this they say that "a crop without the *páitsál* is like a man compelled to go without his breakfast" and the operation must not be delayed, for they point out that a thing may be "as useless as harrowing after five days." So strongly are they impressed with the value of after-cultivation that they tell us to "work in the field incessantly from the time of sowing" and that "one hoeing is as good as ten ploughings." So also the Tamils say "hoe your standing crop; rather miss sowing in season," which, when the extreme importance attached to timely sowing is remembered, could scarcely be more forcibly put. So too they say "root out the weeds when they begin to sprout"; "he is blind who does not weed," "and one who weeds thoroughly has a treasure" as "weeding leads to vigorous growth" and "deceitful hearts and fields foul with weeds will never thrive." In both languages, the difficulties of dealing with the Cynodon dactylon are alluded to: thus in Tamil they say that "the husband of an unruly wife and he who cultivates a field full of *hariali* grass will be ruined,"

and in Telugu that "the field overgrown with *garika* will be grazed by asses." In Tamil also the evils of the weed Cyperus rotundus are pointed out, for "he who has land overgrown with *Kórai* and he who has married a barren woman will not reap any benefit," and there is no more serious drawback to the success of the cultivator than the presence of this weed in his field. Among the Tamils also it is held that "*Palli* (Striga densiflora—a common parasite on the cereals) is as fatal to the field as *Sakuni* (the evil councillor of Duryodhána) was to the family" and "a blighted crop and a family that is 'overlooked' do not thrive."

Space does not permit of my indulging in further references to these mines of information and advice, mostly of very useful and apposite character, though they are far from being well known, especially with regard to the great branch of agriculture connected with the management of livestock, whilst there is much to be said regarding particular crops; and, though the subject is a fascinating one, the study of which I should be glad to continue with aid from anyone in India who can and will add to the collections already available, I must close with a saying as apposite in this respect as in that to which it really refers, namely, "a whole year's livelihood depends on one day's opportunity (for sowing)."

JUTE EXPERIMENTS IN BENGAL.

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In this article I propose to give a short account of the principal results of the agricultural experiments with jute made by the Bengal Department of Agriculture under my supervision at the Experiment Stations of Burdwan and Cuttack. The experiments have been conducted for three years at Burdwan, but for only one year at Cuttack. The most important test was that in which jute was grown in rotation with paddy in the same year, the result of which is given separately in the last section of this article.

Burdwan.

In this section, I give the results of all the jute experiments at the Burdwan Experimental Station up to and including the Jute Season, 1906. The programme of experiments of preceding years was continued in 1906.

Meteorology.—The following table shows the rainfall recorded on the farm during the first eight months of the year 1906 :—

Month.	Rainfall in inches.	Rainy days.
January	1·77	3
February	6·40	7
March	3·53	5
April	*Nil*	*Nil.*
May	6·08	8
June	5·19	11
July	12·30	12
August	17·68	20

In April there was no rainfall, so that it was the second week of May before sowing took place. This is the reason why the crop was so late this year.

Soil.—The soil of the farm is a poor sandy loam. The following are analyses of average samples of soil and sub-soil of the farm :—

	Soil, first 9″.	Sub-soil, second 9″.
Insoluble silicates and sand	88·52	87·48
Ferric oxide	3·60	3·68
Alumina	4·42	5·27
Lime	·34	·33
Magnesia	·34	·31
Potash	·31	·32
Soda	·09	·07
Phosphoric acid	·02	·03
Sulphuric acid	·01	·005
Carbonic acid	·04	·06
Organic matter and combined water ...	2·31	2·45
	100·00	100·00
Available potash	·04	·02
Ditto phosphoric acid	·002	·001
Ditto nitrogen	·011	·007

The figures denote that the land is exceedingly poor in nitrogen and phosphoric acid, poor in lime, but possibly contains enough potash.

Scheme of experiments.—The following experiments were carried out :—(*a*) Manure test; (*b*) Cutting at different stages; (*c*) Variety experiment; (*d*) Spacing experiments; (*e*) Thick *versus* thin sowing in the production of seed; (*f*) Drill *versus* broadcast sowing; (*g*) Rotation experiment with paddy.

Seed was sown in the second week of May, the crop was cut and steeped from the second week of August to the end of September, and retting took 12 to 15 days in each case. The land received eight ploughings and three ladderings, and the crop received three *bidarings*, one thinning, two weedings, and one watering.

(*a*) *Manurial test.*—The scheme is to apply 30 lbs. of nitrogen per acre. Manures were analysed before application: one-twentieth acre plots were taken, and the *deswal* variety of jute was sown. Seed was sown on the 16th May and the crop was

harvested on the 7th September. All the manures were applied just before sowing the seed. The following table gives this year's yields in comparison with those of 1904 and 1905:—

Manures.	Outturn of fibre per acre. 1904. lbs.	1905. lbs.	1906. lbs.
Cowdung	1,985	1,805	1,880
Castor-cake	1,635	1,570	1,860
Bonemeal	1,085	1,580	1,560
Bonemeal and saltpetre	1,605	1,590	1,600
No manure	1,230	1,545	1,560

Again, cowdung gives the best result. but the difference this year between castor-cake and cowdung is not so marked as in previous years.

The following table shows the economic results of the experiment for 1906:—

Quantity of manure applied per acre.		Actual outturn per one-twentieth acre.	Outturn of fibre per acre.	Cost of cultivation per acre. Cost of manure.	Cost of cultivation.	Total.	Money value of outturn.	Profit per acre.
	Mds. srs.	lbs.	lbs.	Rs. A.	Rs. A.	Rs. A.	Rs.	Rs. A.
Cowdung ...	68 20	94	1,880	2 13	12	53 9	230	176 7
Castor-cake ...	7 13	93	1,860	15 0	13	65 13	227	161 3
Bonemeal ...	11 10	78	1,560	22 8	50 7	73 15	100	117 1
Bonemeal and saltpetre	5 30 3 20	80	1,600	20 10	50 7	71 1	195	124 15
No manure ...	...	78	1,560	...	49 2	49 2	190	140 14

Calculating the fibre at Rs. 10 per maund, the cowdung plot shows a profit of Rs. 176-7 per acre. This is about Rs. 36 per acre more profit than the unmanured plot. At the present prices, even the unmanured plot shows a large profit.

The appraisement of the quality of the jute grown each year in the different plots is shown in the next table :—

Year	Manure experiments.	Colour.	Strength.	Length.	Fineness.	Absence of root.	Value per maund.	Remarks.
							Rs. A.	
1906.	(1) With cowdung ..	8	14	16	8	11	10 12	
	(2) ,, castor-cake ...	9	15	16	10	13	11 8	
	(3) ,, bonemeal .	10	16	12	12	11	10 3	
	(4) ,, bonemeal and salt-petre.	8	16	12	10	12	10 8	
	(5) Unmanured ...	12	14	8	12	13	10 12	
1905.	(1) With cowdung ...	...	15	15	...	15	...	Best : poor colour. Fineness and colour cannot be defined on account of the fibre being destroyed.
	(2) ,, castor-cake ...	...	12	14	...	15	..	
	(3) ,, bonemeal ...	...	12	14	...	15		
	(4) ,, bonemeal and salt-petre.	..	10	14	...	15		
	(5) Unmanured ..	.	14	15	..	15	..	
1904.	(1) With cowdung .	13	13	13	13	14	8 10	
	(2) ,, castor-cake ...	10	12	11	11	14	8 6	
	(3) ,, bonemeal ...	11	11	10	11	14	8 5	
	(4) ,, bonemeal and salt-petre.	11	10	10	11	13	8 5	
	(5) Unmanured ...	15	14	10	13	13	8 6	

The figures are not so very decisive, although the fibre from the cowdung plot is the best. taking the result of all three years into consideration.

(*b*) *Cutting at different stages.*—As in 1904 and 1905, plants were cut at different stages of maturity to see which is the best time to cut the jute crop to obtain the best quality and the largest quantity of fibre.

Five tons of cowdung per acre were applied as manure, and farm-grown seed of *deswal* variety was sown. Seed was sown on the 12th May. The first stage was cut on the 2nd August, second stage on the 13th August, third stage on the 23rd August, fourth stage on the 5th September, and fifth stage on the 7th October. Steeping took place in each stage one day later than the cutting, and retting took 12 to 14 days in each case.

The following table shows the results of the past two years :—

Cutting stages.	Outturn per acre. 1906. lbs.	1907. lbs.
(1) Before flowering	1,300	1,130
(2) In flower bud	1,630	1,600
(3) ,, flower	1,690	1,890
(4) When fruits are set	1,800	1,935
(5) ,, ,, ,, dead ripe	1,810	2.030

This shows that the longer the crop is allowed to grow, the heavier is the yield of fibre. The difference is very great between the first two and the last two stages of cutting, but is not so much between the last three stages of cutting. There is very little difference in the quality of the fibre of all five stages. Hence the best time to harvest the crop will depend upon the rotation adopted. If jute be followed by *aman* paddy, the third stage is best, for then a crop of *aman* paddy can be obtained in addition to jute in the same year. If potatoes follow jute, it will pay best to allow the crop to become ripe before harvesting.

The following statement gives the expert valuation of the fibre from the plants cut at different stages for the three years :—

Cutting at different stages.	Valuation per maund. 1904. Rs.	A.	1905. Rs.	A.	1906. Rs.	A.
(1) Cut before flower bud ...	7	8	10	0	9	0
(2) ,, in flower bud	8	3	10	4	12	12
(3) ,, ,, flower	8	1	10	8	12	10
(4) ,, when fruits have set ..	8	3	10	4	12	8
(5) ,, ,, ,, ,, matured ..	8	3	10	0	12	4

Practically speaking, there is little or no difference in the quality of the fibre from a crop cut at different stages of ripening. Plants cut when in stages (2) and (3) produce the best quality of fibre.

(*c*) *Variety experiment.*—In this province two species of jute are grown, viz., *olitorius* and *capsularis*. There are many so-called varieties of each species. Forty-eight varieties of *Corchorus capsularis* and nine varieties of *C. olitorius* have been compared at Burdwan. Fifty-six varieties were tested in 1906. Plots, one-sixtieth of an acre in extent, were chosen and manured with cowdung at the rate of 5 tons per acre. Seed of different varieties were sown on the 11th May, and the plots received the same treatment throughout. In 1904 seed was collected from the different districts and sown. In 1905 we employed the seed obtained from the different varieties grown on the farm in 1905. In 1906 we employed farm-grown seed obtained from the crop of 1905.

The following table gives the outturn and valuation per maund of fibre for each variety for 1904, 1905 and 1906 :—

Serial No.	Name of variety.	Locality from which obtained.	1904. Outturn per acre.	1904. Value per maund.	1905. Outturn per acre.	1905. Value per maund.	1906. Outturn per acre.	1906. Value per maund.
1	2	3	4	5	6	7	8	9
	Corchorus capsularis.		lbs.	Rs. A.	lbs.	Rs. A.	lbs.	Rs. A.
1	Baran ...	Mymensingh ...	1,875	9 0	2,060	9 8	2,160	11 8*
2	Barapat ...	Do. ...	1,770	8 8	2,060	9 8	1,920	11 4*
3	Kakyabombai ...	Sirajganj ..	1,905	3 3	2,060	9 6	2,080	11 4*
4	Deswal ...	Do. ...	1,552	8 8	1,780	9 12	1,920	11 8
5	Barapat ...	Do. ...	1,775	8 6	1,640	9 12	1,680	12 0
6	Nailta ...	Do. ...	1,785	8 6	1,580	7 8	1,760	11 0†
7	Nalpat ...	Faridpur ...	1,830·6	8 5	1,540	9 4	1,560	10 12†
8	Amonia ..	Do. ...	1,635	8 5	2,200	10 0	2,160	11 0†
9	Kamarjani ...	Do. ...	1,125	8 6	1,900	9 6	1,800	10 12†
10	Farm seed ...	Burdwan Farm orginally Seraj-ganj.	1,845	8 12	1,900	9 8	1,040	11 8‡
11	Dhaleswari ...	Dacca ...	1,792·8	8 5	1,740	9 8	1,760	11 8‡
12	Belgachi ...	Faridpur ...	1,395	8 4	1,440	9 4	1,800	11 4
13	Farm seed ...	Burdwan Farm	1,665	8 3	1,720	10 0	2,400	11 0
14	Agneswar ...	Dacca ..	1,635	8 0	1,660	9 6	1,640	10 12
15	Belgachia ...	Do. ...	1,650	8 5	1,780	9 8	1,440	10 8§
16	Bidyasundar ...	Do. ...	1,575	8 3	1,440	8 8	1,840	11 0§
17	Desi ..	Do. ...	1,620	8 6	1,520	9 0	1,680	11 0§
18	Desinallya ...	Do. ...	1,560	8 3	1,640	9 10	1,920	11 4§
19	Dhalsundar ...	Do. ...	1,065	8 0	1,600	10 0	1,920	11 0§
20	Farm seed ...	Burdwan Farm	1,815	8 12	2,600	9 12	2,600	10 12
21	Kajla ...	Dacca ...	1,245	8 12	1,440	9 4	1,520	10 8
22	Parbatia ...	Do. ...	1,365	8 6	1,600	9 8	1,760	10 12
23	Aus ...	Mymensingh ...	1,320	8 4	1,600	9 10	1,680	10 8
24	Parbatia ...	Do. ...	1,275	8 2	1,800	9 10	1,840	11 8
25	Chotaput ...	Do. ...	1,320	8 2	1,800	9 10	1,680	11 12
26	Deswal, white ...	Sirajganj ...	1,455	8 5	1,600	9 8	2,000	11 4
27	Do., red ...	Do. ...	1,335	8 6	1,700	9 8	1,630	11 0
28	Tosha ...	Do. ..	1,245	8 1	1,800	9 8	1,760	10 12
29	Deodhali ...	Tippera ...	1,155	8 3	1,580	9 10	1,640	11 4
30	Farm seed ...	Burdwan Farm	1,230	8 10	2,080	10 0	2,160	11 4*
31	Phuleswari ...	Tippera ...	1,650	7 8	1,540	9 14	1,920	11 0
32	Betri, red ...	Rangpur ...	1,110	8 6	1,500	9 10	1,760	11 4
33	Do., white ...	Do. ...	1,215	8 6	1,520	9 8	1,720	11 8¶
34	Hewti, red ...	Do. ...	1,440	8 3	1,620	9 12	1,920	11 4¶
35	Do., white ...	Do.	2,310	8 6	1,520	9 12	1,640	11 4
36	Bhadoy, Do. ...	Jalpaiguri ...	1,380	8 8	1,860	9 8	2,080	81 0
37	Do., red ...	Do. ..	1,335	8 6	1,760	9 10	1,360	12 0
38	Do., Do. ...	Do. ...	1,230	8 2	1,500	9 10	1,680	11 0
39	Udhappat ...	Faridpur ..	1,365	8 1	1,620	9 8	1,680	11 0
40	Farm seed	Burdwan Farm	1,500	8 1	2,200	9 12	2,320	11 0
41	Sutpat ...	Faridpur ...	1,800	7 2	1,200	9 0	1,400	11 0
42	Dhalsunda ...	Dacca ..	1,150	7 12	1,780	9 10	1,840	11 4
43	Baran ..	Mymensingh ...	1,590	8 2	1,680	9 12	1,840	11 4
44	Hewti ..	Rangpur ...	1,425	8 6	1,640	10 0	1,920	11 4
45	Bhadoya ...	Jalpaiguri ..	1,365	8 5	1,580	9 10	1,720	11 4
46	Hewti ...	Do.	1,395	8 4	1,680	9 12	1,880	11 4
47	Farm seed ...	Burdwan Farm	1,680	8 4	1,700	9 10	2,560	11 12

* Too much steeped.
† Very weak ; too much steeped.
‡ Weak ; too much steeped.
§ Steeped too long.
¶ Over-steeped.

Serial No.	Name of variety.	Locality from which obtained.	1904. Outturn per acre.	1904. Value per maund.	1905. Outturn per acre.	1905. Value per maund	1906. Outturn per acre.	1906. Value per maund.
1	2	3	4	5	6	7	8	9
	Corchorus olitorius.		lbs.	Rs. A.	lbs.	Rs. A.	lbs.	Rs. A.
48	Tosha ...	Pabna ...	1,365	8 6	1,760	10 0	1,680	12 0
49	Satnalla ...	Faridpur ...	1,275	8 6	1,600	10 0	1,840	12 0
50	Desilalpat ...	Hooghly ...	1,365	8 6	1,600	9 14	1,680	11 0
51	Bangi ..	Dacca ...	...		1,760	9 14	1,800	11 12
52	Deonalya ...	Do. ..	885	8 4	1,140	9 14	2,000	11 12
53	Nailta .	Mymensingh ...	1,050	8 1	8—1	9 10	2,440	12 2
54	Paknallya ...	Do. ...	1,125	7 8	2,640	10 0	2,080	12 0
55	Tosha ...	Pabna ...	1,290	7 8	2,160	10 0	2,240	11 12
56	Halbilati ...	Tippera ...	960	7 8	2,240	10 0	2,480	11 12

Many of the varieties have done exceedingly well this year. The following varieties yielded more than 25 maunds of fibre per acre :—

Corchorus capsularis—	lbs.
(1) Baran, Mymensingh	2,160
(2) Kakyabombai, Serajganj	2,080
(3) Amonia, Faridpur	2,160
(4) Deswal (farm-grown seed)	2,400
(5) Do. (ditto)	2,160
(6) Bhadoya, white, Jalpaiguri	2,080
(7) Deswal (farm-grown seed)	2,320
(8) Do. (ditto)	2,560
Corchorus olitorius—	lbs.
(1) Nailta, Mymensingh	2,440
(2) Paknallya, ditto	2,080
(3) Tosha, Pabna	2,240
(4) Halbilati, Tippera	2,480

and their quality is upheld by the appraisement figures.

The most striking feature of this experiment is the continuous superiority of the Deswal farm-grown seed. (1) Baran of Mymensingh. (2) Amonia of Faridpur. (3) Kakyabombai of

Serajganj, (4) Deswal of Serajganj, and (5) Barapat of Mymensingh (*Corchorus capsularis*), and (1) Nailta of Mymensingh, (2) Paknallya of Mymensingh, (3) Tosha of Pabna, and (4) Halbilati of Tippera (*Corchorus olitorius*) are recommended to the notice of cultivators, and special attention is called to the benefit of selecting and keeping strong plants for the production of one's own seed-supply. Practically speaking, the above varieties of jute (also any other so-called variety of Bengal jute) may be classed as red or green-stemmed *Corchorus capsularis*, and red or green-stemmed *Corchorus olitorius*. There is no evidence, so far as plant-growth goes, to prove that we are dealing with fifty-six different varieties :—

Corchorus capsularis, green-stemmed—

		Flowered in 1906.
(1)	Baran	1st week of August.
(2)	Barapat	1st „ „
(3)	Kakyabombai	1st „ „
(4)	Deswal	1st „ „
(5)	Barapat	1st „ „
(8)	Amonia	1st „ „
(9)	Kamarjani	1st „ „
(10)	Deswal (farm seed)	2nd „ „
(11)	Dhaleswari	1st „ „
(12)	Belgachi	2nd „ „
(13)	Deswal (farm seed)	2nd „ „
(15)	Belgachi	1st „ „
(17)	Desi	2nd „ „
(18)	Desinallya	1st „ „
(19)	Dhalsundar	1st „ „
(20)	Deswal (farm seed)	2nd „ „
(21)	Kajla	1st „ „
(22)	Parbatia	1st „ „
(23)	Aus	1st „ „
(24)	Parbatia	1st „ „
(26)	Deswal, white	1st „ „
(27)	Deswal, red (with red leaves)	1st „ „
(28)	Tosha (with red flowers)	1st „ „
(29)	Deodhali, ditto	1st „ „
(30)	Farm seed	2nd „ „
(31)	Phuleswari	2nd „ „
(33)	Betre, white	1st „ „
(34)	Hewti, red	1st „ „
(38)	Bhadoya, red	1st „ „

		Flowered in 1906.
Corchorus capsularis, green-stemmed—*concld.*		
(39)	Uddhappat	1st week of August.
(40)	Farm seed	2nd " "
(41)	Sutpat	2nd " "
(42)	Dhalsundar	1st " "
(43)	Baran	1st " "
(44)	Hewti	1st " "
(45)	Bhadoya	1st " "
(46)	Hewti	1st " "
(47)	Farm seed	2nd " "
Corchorus capsularis, red-stemmed—		
(6)	Nailta	1st week of August.
(7)	Nalpat	1st " "
(14)	Agneswar	2nd " "
(16)	Bidyasundar	2nd " "
(25)	Chotapat	1st " "
(32)	Betre, red	1st " "
(35)	Hewti, white	1st " "
(36)	Mixed seed	1st " "
(37)	Bhadoya, red	1st " "
Corchorus olitorius, green-stemmed—		
(51)	Bangi	3rd week of August.
(50)	? mixed seed	
(53)	? ditto	
(54)	? ditto	
Corchorus olitorius, red-stemmed—		
(48)	Tosha	1st week of August
(49)	Satnalla	3rd " "
(55)	Tosha	2nd " "
(56)	Halbilati	2nd " "

Hence, amongst the above fifty-six so-called varieties, *Corchorus capsularis* appears to be generally green-stemmed, while *Corchorus olitorius* is commonly red stemmed. This appears to be the case throughout Bengal. This would seem to be corroborated by the greater prolificness of the green-stemmed *capsularis* over the red-stemmed, and by the red-stemmed *olitorius* over the green-stemmed. Accordingly, a green-stemmed *capsularis* or a red-stemmed *olitorius* should be chosen.

(*d*) *Spacing experiment.*—In this experiment the Deswal variety was employed. No manures were applied. The crop received the same treatment as in the manure experiment, except that at thinning time, in one plot plants were thinned out to 4 inches apart, in another to 6 inches apart, in a third to 8 inches apart, and in a fourth to 10 inches apart.

The following table gives the results of the last three years :—

Degree of spacing, in inches.	Outturn of fibre per acre, in lbs.		
	1904.	1905.	1906.
4	2,079	1,319	660
6	1,478	1,190	1,176
8	882	1,025	1,020
10	1,183	797	912

The results for 1906 on the whole tend to corroborate those obtained in previous years, *viz.*, that thinning out plants to 4 inches apart is the best distance. The poor yield in the 4-inch thinned-out plot in 1906 is due to negligence on the part of the Overseer, who failed to observe uniform conditions throughout the experiment. The plants in the 4-inch thinned-out plot were only half the size of the plants in the 6-inch thinned-out plot, showing great difference in uniformity of the two plots. The figures for 1906 are given with due reserve, and this point should be borne in mind. There is very little difference in the quality of the fibre from all the plots.

(*e*) *Experiment with seed-supply.*—This experiment is to compare the effects of sowing seed thinly and thickly, saving seed therefrom, and comparing the outturn and fibre from seed obtained in each way.

The following table shows the results for 1906 :—

		Outturn in lbs.
(*i*) Seed obtained from last year's crop for which the seed was sown thickly.	(*i*) Seed sown thickly in 1906	1,410
	(*ii*) Seed sown thinly in 1906	1,500
(*ii*) Seed obtained from last year's crop for which the seed was sown thinly.	(*i*) Seed sown thickly in 1906	1,584
	(*ii*) Seed sown thinly in 1906	1,782

The results tend to show that thin sowing, which gives a little more air and sunshine, tends to produce better seed.

(*f*) *Drill* versus *broadcast sowing.*—One-fourth acre plots were chosen. In one plot the seed was sown broadcast, while in the other seed was sown in drills by means of an indigo drill adjusted to deal with jute seed. The crop received the same treatment throughout. As results were almost equal, nothing can be stated in favour of either method. Also as seed is cheap and the crop is thinned out to 4 inches apart while young, there is no advantage to be gained by sowing seed by means of drills on small areas. For large areas, with the object of simplifying the thinning process, there might be some advantage in using the drill. The valuation is just in favour of drill sowing.

Conclusions.

1st.—Jute grows very well in rotation with *aman* paddy and potatoes. On low-lying land a good crop of *aman* paddy can be obtained, while on high irrigable land potatoes may be grown after jute in the same year.

2nd.—For the Burdwan district the third week of April should see all jute sown, to ensure a good crop of *aman* paddy the same year on the same land. For potatoes to follow jute, the jute seed time is not so important.

3rd.—Sixty-eight and-a-half maunds of cowdung, or $7\frac{1}{4}$ maunds of castor-cake, per acre applied just before sowing the seed will well repay the cost of their application.

4th.—In choosing seed, it is advisable to select a green-stemmed *capsularis* variety, or a red-stemmed *olitorius* variety. Of the former, (1) Baran of Mymensingh, (2) Amonia of Faridpur, (3) Kakyabombai of Serajganj, (4) Deswal of Serajganj, and (5) Barapat of Mymensingh, and of the latter, (1) Tosha of Pabna, (2) Satnalla of Faridpur, (3) Halbilati of Tippera varieties are recommended to the notice of cultivators.

5th.—The jute seed-bed can be well prepared by eight ploughings with the ordinary country plough, and by three ladderings with the ordinary country ladder.

6th.—The after-cultivation will be well done by passing the local *bida* over the field when the plants are 2 inches high, and by thinning the plants out to 4 inches apart when they are 6 inches high. Possibly one weeding may be necessary.

7th.—Special emphasis is laid on the great benefit that is to be derived from taking a suitable variety, growing the plants with plenty of light, and saving the seeds from the strongest and healthiest plants for the next year's crop. If this be continued for several years, there will be produced seed that will give much stronger and larger plants than the original seed.

Cuttack.

In 1905 it was found that jute grows well on the Cuttack farm, so a series of experiments on this crop was inaugurated this year.

Meteorology.—The following table shows the rainfall recorded on the farm during the first nine months of the year:—

Months.		Average rainfall in district, in inches.	Farm amount, in inches. 1906.	Number of rainy days.
January ...		0·32	·21	2
February ...		0·63	2·72	7
March ...		0·85	·09	3
April ...		1·49	·01	1
May ...	1st week	2·94	·01	1
	2nd ,,		·20	1
	3rd ,,		·89	1
	4th ,,		·66	
			2·76	5

Months.		Average rainfall in district, in inches.	Farm amount, in inches, 1906.	Number of rainy days.
June	1st week	9·72	1·07	2
	2nd ,,		·64	3
	3rd ,,		2·44	5
	4th ,,		2·24	5
			6·39	15
July ...	1st week	11·86	1·24	5
	2nd ,,		·72	4
	3rd ,,		3·22	7
	4th ,,		1·69	8
			6·87	24
August ...	1st week	13·31	1·02	3
	2nd ,,		1·62	5
	3rd ,,		·03	1
	4th ,,		3·82	6
			8·46	15
September	1st week	9·91	4·09	6
	2nd ,,		1·24	3
	3rd ,,		·91	4
	4th ,,		2·22	2
			8·46	15

The seed time in Cuttack for jute is the end of March and the beginning of April. The average rainfall of the district for January, February, March and April is only 3·29 inches, and hence irrigation may be said to be necessary for this crop. The ordinary canal lease for *aman* paddy land lasts from June to the

end of March. Hence irrigation up to the end of March is possible without extra cost. Then with ordinary good luck, the crop will thrive well enough till the monsoon comes when the crop flourishes. In 1906 the plentiful rains of February allowed of all cultivation being done without irrigation. March was very dry, and one irrigation was necessary in the first week of April to allow of the preparation of the seed-bed and to supply the moisture for germination. After that, no further application of water was necessary.

Character of the soil.—Excepting a few acres of high sandy land, the soil is sandy loam, resting on a sub-soil of similar composition. The following table shows the composition of each :—

	Surface soil, 1st 9 inches.	Sub-soil, 2nd 9 inches.
Insoluble silicates and sand	86 66	84·33
Ferric oxide	3 74	4·83
Alumina	5 52	6·37
Lime	·30	·39
Magnesia	·59	·41
Potash	·24	·33
Soda	·03	·17
Phosphoric acid	·03	·03
Sulphuric acid	·01	·007
Carbonic acid	·05	·06
Organic matter and combined water	2·83	3·07
Total ...	100·00	100 00
Nitrogen	·04	·02
Available phosphoric acid	·002	·001
Available potash	·004	·004

The soil is rather poor in nitrogen, phosphoric acid, potash and lime.

Experiments.—The scheme included (1) Manurial ; (2) Cutting at different stages ; (3) Variety.

Seed-time, second week, April. Harvest, August, first to fourth week. The land received eight ploughings, six ladderings, one on irrigation thinning, and one harrowing.

Manurial.—The following manures, in kinds and quantities as stated below, were compared. Deswal of Serajganj variety was

employed. Seed was sown on the 10th April and the crop was harvested on the 17th August. The following are the results :—

			Yield.			
			One-fifth acre plot.		Per acre.	
			Mds.	srs.	Mds.	srs.
1.	Unmanured	...	1	33	9	5
2.	Cowdung, 100	maunds ...	1	39	9	35
3.	Cowdung, 100 Saltpetre, 1½	,, ,,	2	15	11	35
4.	Cowdung, 100 Superphosphate, 3	,, ,,	2	9	11	5
5.	Cowdung, 100 Superphosphate, 3 Saltpetre, 1½	,, ,, ,,	2	26	13	10

To the above another plot may be added (No. 6), which had grown potatoes in the preceding two years and had been heavily manured with village refuse and oil-cake. Plots Nos. 1 to 5 grew *aus* paddy in 1905, and have most probably never been manured. In plot No. 6 seed was sown on the same day as the others, and harvested on 24th August. Deswal seed was sown and 100 maunds of cowdung per acre were applied. The following is the yield :—

	Outturn, one-fifth acre.		Outturn per acre.	
	Mds.	srs.	Mds.	srs.
6. Cowdung, 100 maunds ...	5	2½	25	12½

The following statement shows the economic results of the plots :—

	Yield per acre.	Cost per acre.			Value outturn per acre.	Profit per acre.
		Cultivation.	Manures.	Total.		
	Mds.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A.	Rs. A.
(1) Unmanured	9⅛	21 13 6		24 13 6	91 4	66 6
(2) Cowdung	9⅞	24 13 6	51 1 0	29 13 6	98 12	68 14
(3) Cowdung and saltpetre	11⅞	25 12 6	12 8 0	38 4 6	118 12	80 7
(4) Cowdung and superphosphate	11⅛	25 10 0	12 0 6	37 10 6	111 4	73 9
(5) Cowdung, superphosphate and saltpetre	13	27 5 6	19 8 6	46 14 0	132 8	85 10
(6) Cowdung after potatoes ...	25¼	37 4 3	3 14 6	41 2 9	252 8	211 5

Leaving out plot No. 6 for a moment, the results of the other five demonstrate the efficacy of applying nitrogen, phosphoric acid, potash and calcium in a soluble state to a quick-growing plant like jute whose chief growing period extends over only three months. This experiment was really most interesting, and it was possible to see the effect of the manures from a distance. I do not agree with the figures of the Overseer for plot No. 5, for this plot was examined carefully nearly every fortnight during the season and very little difference could be detected between plots Nos. 5 and 6, and I think the figures for plot No. 6 more nearly represent the outturn of plot No. 5 than the given figures. Still the eye can be misled, and we had better leave it to time to decide the question. Plots Nos. 5 and 6, to the eye, were equal to anything we had at the Burdwan farm.

(*b*) *Variety experiment.*—Deswal of Serajganj, Barapat of Mymensingh, Hewti of Jalpaiguri (all three *Corchorus capsularis*) and Satnala of Faridpur (*C. olitorius*) were compared. The plots were manured at the rate of 100 maunds of cowdung per acre. Seed was sown in the second week of April and the crop was harvested in the second week of August. The outturns were as follows :—

	Outturn	
	$\frac{1}{5}$th acre plot.	Per acre.
	Mds.	Mds.
(1) Deswal...	$1\frac{3}{8}$	$6\frac{7}{8}$
(2) Barapat	$2\frac{1}{8}$	$10\frac{5}{8}$
(3) Hewti	$2\frac{3}{5}$	$13\frac{5}{8}$
(4) Satnala	1	5

Hewti of Jalpaiguri gave the best return. The poor yield all round in this case is due to the fact that in 1905 the land was levelled, *i.e.*, the upper surface of five inches removed.

Quality of Fibre.—The following statement shows the appraisement of the quality of the fibre produced in the different experiments. No distinction can be drawn between the fibres of the different plots as all are valued about the same. The figures

demonstrate that a first-class quality of fibre is produced on the farm.

Description of sample.		Appraisement, 16 annas—in full.						Remarks.
Variety of seed.	Details of experiments.	Colour.	Strength.	Length.	Fineness.	Absence of roots.	Value per maund.	
1	2	3	4	5	6	7	8	9
	Manure experiments.	As.	As.	As.	As.	As.	Rs. A.	
Deswal ...	I.—With cowdung	12	16	12	12	16	11 0	
,, ...	II.—With cowdung and superphosphate .	12	16	12	12	16	11 0	
,, ...	III.—With cowdung and saltpetre	12	16	12	12	16	11 0	
,, ...	IV.—With cowdung, superphosphate and saltpetre ..	12	16	12	12	16	11 0	
,, ...	V.—Unmanured	12	16	12	12	16	11 0	
	Rotation experiments.							
Deswal ...	I.—With *aman* paddy ..	12	10	8	10	16	10 12	
,, ...	II.—With plot No. 30 ..	12	10	8	10	16	10 12	
,, ...	III.— Ditto 24 ...	14	14	16	14	16	12 4	
,, ...	IV.— Ditto 23 ..	14	14	16	14	16	12 4	
,, ...	V.— Ditto ..	14	14	16	14	16	12 4	
,, ...	VI.—After potato crop ...	14	14	16	14	16	12 4	
	Cutting at different stages.							
Deswal ...	I.—Cut before flower bud ...	12	16	8	14	15	10 12	
,, ...	II.—Cut in flower ...	12	16	8	14	15	10 12	
,, ...	III.—Cut when fruits have set ...	12	16	8	14	15	10 12	

Description of sample.			Appraisements.						Remarks.
Local name.	Botanical species.	Original locality.	Colour.	Strength.	Length.	Fineness.	Absence of roots.	Value per maund.	
1	2	3	4	5	6	7	8	9	10
	Variety experiments		As.	As.	As.	As.	As.	Rs. A.	
Banapat ...	C. Capsularis .	Mymensingh ...	12	14	12	12	15	11 0	
Deswal ...	Ditto ...	Serajganj	12	14	12	12	15	11 4	
Hewti ...	Ditto .	Jalpaiguri ..	12	14	12	12	15	11 0	
Satnala ...	C. Olitorius ...	Faridpur ...	12	14	12	12	15	11 4	

Jute in rotation with Paddy in the same year.

Burdwan.—At Burdwan this experiment was commenced in 1905, when a crop of paddy in addition to a crop of jute was obtained from the same land in the one year. After harvesting the jute crop towards the end of July, *aman* paddy was transplanted and the crop was harvested at the same time as the ordinary paddy crop in the beginning of December.

In 1906 the experiment of growing paddy in rotation with jute in the same year was repeated. Jute was sown in the second week of May, and the crop was harvested in the first week of August. *Aman* paddy was transplanted in the third week of August, and the crop was harvested in the first week of December. The land was prepared before sowing by 8 ploughings and 3 ladderings, and the jute crop was *bidared* three times, thinned once and weeded twice; while after the jute crop was harvested, the land was ploughed three times and laddered once to prepare for the transplanting of *aman* paddy. The paddy crop was given one weeding, one hoeing and one watering. The following table shows the result of the experiment during the past two years :—

Crop.	1905. Yield per acre in maunds.		1906. Yield per acre in maunds.	
	Grain.	Fibre or straw.	Grain.	Fibre or straw.
Jute	...	16		$17\frac{2}{5}$
Paddy (coarse)	$15\frac{7}{10}$	$19\frac{2}{5}$	11	22
Jute			..	$17\frac{3}{5}$
Paddy (fine)	...	...	$12\frac{4}{5}$	19

In 1905 meteorological conditions were not favourable to a good paddy crop. In July the abnormal amount of 37·95 inches of rain was recorded, in contrast to an average of 12·32 inches for the district, while 3 inches more than the normal rainfall was recorded in August and September. This caused very unfavourable growing conditions for the paddy crop before September. A yield of 16 maunds of jute followed by an outturn of $15\frac{7}{10}$ maunds of paddy grain and $19\frac{2}{5}$ maunds of straw is, therefore, very reassuring.

In 1906 no rain fell in April, and as the canal was unable to supply water, the jute sowing was three weeks late. Hence the jute harvest was retarded, and the growing period of the paddy crop was shortened by three weeks. The return of $17\frac{2}{5}$ maunds of jute followed by 18 maunds of grain *plus* 22 maunds of straw

from a coarse variety of paddy and $12\frac{4}{5}$ maunds of grain *plus* 19 maunds of straw from a fine variety of paddy, are very satisfactory.

The following table gives full details of the experiment in both years :—

Crop.	Quantity of manure applied per acre.	Date of planting.	Date of harvesting.	Outturn per acre.	
				Grain.	Straw or fibre.
				Mds.	Mds.
1905.					
Jute	Cowdung, 5 tons	1st May 1905	20th July 1905	...	16
Paddy (coarse) ...	No manure ...	3rd Aug. ,,	4th Dec. ,,	$15\frac{7}{10}$	$19\frac{2}{5}$
1906.					
Jute ...	Unmanured ..	10th May 1906	3rd Aug. 1906	...	$17\frac{2}{5}$
Paddy (coarse)	Saltpetre, 30 seers	18th Aug. ,,	5th Dec. ,,	18	22
1906.					
Jute ...	Unmanured ...	10th May 1906	3rd Aug. 1906	...	$17\frac{4}{5}$
Paddy (fine)	Saltpetre, 30 seers	18th Aug. ,,	5th Dec. ,,	$12\frac{4}{5}$	19

In 1905, $\frac{1}{10}$ acre plots were taken. These plots had for the previous five years only grown jute each year. Cowdung at the rate of 5 tons per acre was applied to the land before the last ploughing in the preparation of the jute seed-bed, and the paddy crop received no manure In 1906, four $\frac{1}{12}$ acre plots were taken on land that had previously grown sugarcane. No manure was applied to the land for the jute crop, but the paddy crop was top-dressed with 30 seers of saltpetre per acre.

The following statement shows the economic results of the experiment in 1906 :—

Crop.	Yield per acre.		Cost of Cultivation.	Money value of outturn.	Profit.	
	Grain.	Fibre or straw.			Per crop.	Per acre.
	Mds	Mds.	Rs. A.	Rs. A.	Rs. A.	Rs, A.
Jute	..	$17\frac{2}{5}$	52 6	179 7	127 1	..
Coarse paddy ..	18	22	35 1	57 3	22 2	149 3
Average of 79, 80 and 81—3 plots. Jute ...	..	$17\frac{4}{5}$	56 13	180 12	123 15	...
Average of 79, 80 and 81—3 plots. Fine paddy	$12\frac{4}{5}$	19	36 0	64 13	28 13	152 12

These figures do away entirely with the idea that if the area of jute cultivation is increased, the people's food-supply will be imperilled, for not only is the raiyat's food-supply assured by the paddy crop, but in the same year a crop of jute is obtained

from the same land, and this extra crop will enable the cultivator to obtain other necessities of life than those ensured by the paddy crop. A net profit of Rs. 150 per acre is well worthy of a farmer's consideration.

Cuttack.—At Cuttack the same experiment of growing *aman* paddy in rotation with jute on the same land in the same year was commenced in 1906. Land that probably has only previously grown paddy was selected. Two plots, one-fifth of an acre each, were taken. As the land was very poor, a good dressing of cowdung, at the rate of 400 maunds per acre, was applied. *Deswal* jute was sown on April 10th and the crop was harvested on August 21st, after which the *aman* paddy was transplanted on August 26th, and the crop was harvested in December.

The following table shows the result of the experiment :—

Crop.	Manure	Planted.	Harvested.	Yield per Acre.	
				Grain.	Fibre or straw.
				Mds.	Mds.
Jute	Cowdung, 400 maunds	10th April ...	21st August		$17\frac{3}{4}$
Paddy	Unmanured	26th August	5th December	$18\frac{5}{8}$	$33\frac{1}{8}$
Jute	Cowdung, 400 maunds	10th April	21st August		15
Paddy	Unmanured	26th August	5th December	$17\frac{3}{8}$	$35\frac{1}{8}$

An average crop of $16\frac{3}{8}$ maunds of jute, followed by an average yield of 18 maunds of paddy grain, *plus* $34\frac{1}{4}$ maunds of straw was obtained per acre. This must be regarded as very satisfactory when it is remembered that jute is a new crop in the district.

The following table shows the economic results of the experiment :—

Crop.	Yield per Acre.		Cost of cultivation.	Money value of outturn.	Profit.	Profit per acre.
	Grain.	Fibre or straw.				
	Mds.	Mds.	Rs. A.	Rs. A.	Rs. A.	Rs. A.
Jute		$17\frac{3}{4}$	44 13	177 8	122 11	...
Paddy	$18\frac{5}{8}$	$33\frac{1}{8}$	18 6	43 0	24 10	157 5
Jute	..	15	44 13	150 0	105 3	.
Paddy	$17\frac{3}{8}$	$35\frac{1}{8}$	18 6	41 0	22 10	128 13

Hence an average net profit of Rs. 143 per acre per annum was obtained.

Conclusions.

1. On *aman* paddy land, both jute and paddy can be grown in rotation with each other on the same land in the same year.

2. For the Burdwan district, the third week of April should see the jute sown to enable the jute crop to be harvested in the last week of July and the *aman* paddy to be transplanted in the first week of August. The land should be cultivated for 8 to 10 days between the harvesting of the jute and the transplanting of the *aman* paddy.

3. For the Cuttack district, the jute seed should be sown in the last week of March, and the jute crop should be harvested in the end of July.

4. The jute seed-bed can be well prepared by 8 ploughings with the ordinary country plough and by 3 ladderings with the ordinary country ladder.

5. For paddy the land is well prepared with 3 or 4 ploughings with the ordinary country plough and 1 or 2 ladderings.

6. An application of 100 maunds of cowdung per acre to the land before sowing jute and a top dressing of one or two maunds of saltpetre per acre to the paddy crop when the land is just moist (*i.e.*, when the soil is beginning to dry) will be found very efficacious.

7. The raiyat's food-supply is not only assured, but the extra jute crop gives a handsome profit.

THE TRIAL OF EXOTIC DROUGHT-RESISTING PLANTS IN INDIA.

By F. G. SLY, I.C.S.,

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From time to time recommendations are received for the introduction from other countries of drought-resisting fodder plants, as a remedy for the heavy losses of cattle that occur in famines. The most important of these recommendations have been made by the Indian Famine Union, who, in 1902, urged the experimental trial of several Australian and South African salt-bushes and sheep-bushes. In 1903, the same institution drew attention to the successful work done by the United States Department of Agriculture in the introduction of Australian salt-bushes into arid tracts, more particularly in alkali soils. Considerable attention has been given to this subject in India, and it seems desirable to give a short account of the more important trials. I am indebted to Directors of Agriculture and other Government officers for the necessary information.

The most detailed trials have been made in the United Provinces, with the dual object of introducing a good fodder plant and of reclaiming the large alkali tracts, known as *reh* or *usar*. The tests have been usually made both at the Saharanpore Botanical Gardens and at the alkali stations in charge of the Provincial Department of Agriculture. The late Mr. Gollan, Superintendent of the Government Botanical Gardens, has supplied the following summary of the results of experimental tests.

Pentzia virgata.—The South African Sheep Bush. "This plant closely resembles an Artemisia, and is said to be a good fodder for sheep and goats in its native country and in some parts

of Australia, where it has been introduced. It has also been strongly recommended as a suitable plant to introduce into dry sandy tracts and for culture in saline soils. As it was thought it might prove useful for culture in the *reh*-infected tracts in these provinces, seeds were procured in the year 1883 from the Botanic Gardens, Adelaide, and were tried at Saharanpore. Seeds sown in March came up freely, but even under pot culture in the shelter of a verandah, only a few sickly-looking plants survived the rains. These recovered after the cold season had fairly set in, and by the beginning of the following rains had developed into strong healthy-looking plants. Some of these were planted out in the ground, and others were retained under pot culture in cover. Those put out in the ground all died before the end of the first rainy month, and those which were under cover only survived for a few weeks longer. The plant may succeed in Sind or in other drier parts of the Punjab, but in these provinces it stands no chance whatever. It does not now exist in the garden, and is also probably completely lost to the country. It is easily raised from seed sown in the autumn or in the spring. Cuttings put down in December rooted freely.

"*Australian salt bushes* (*Chenopodiaceæ*).—These plants have a great reputation in Australia for thriving on dry and salt land; many of them form excellent feeding for stock. Different species have been tried in this country, mainly with a view to determine whether they would grow on alkali soils and contribute to the establishment of fodder reserves. The most complete trials were of *Atriplex nummularia* (Linn). Grown in the Saharanpore Garden, this species did well and produced seed; the plants died off in five to seven years. The plants raised from seed gathered in the gardens were short-lived, and never so healthy as those from imported seed, dying in about three years. The plantation was allowed to die out, as there was no demand for seed, but a fresh supply has now been received. Seeds can be sown any time between October and March, or cuttings can be put down in the rains and the cold weather, but a very small percentage of these root. Planted out on alkali lands in Cawnpore,

Etah and Aligarh, the plant died out in every case ; the Director of the Botanical Department considers that the wetness of these lands during the rains was fatal to the plant.

"The following species have also been grown in the Saharanpore Gardens :—(1) *Atriplex halimoides ;* (2) *A. palulus ;* (3) *A. vesicaria ;* (4) *A. leptocarpa ;* (5) *A canescens ;* (6) *A. prastralum ;* (7) *A. spongiosum ;* (8) *A. semibaccata ;* (9) *Chen. nitrareaceum ;* (10) *Kochia villosa ;* (11) *K. brownii ;* (12) *K. sponpocarpa.* Many of these failed to germinate, and not one species throve during the rains ; none of them attained anything beyond the stage of pot plants. *Kochia sponpocarpa* is still under trial. The general conclusion drawn from observation of these and other species obtained from Australia, is that the failure is due to the combination of heat and moisture during the monsoon season."

The soil in the garden is all an alluvial loam of somewhat stiff texture, so that no comparison of results in different kinds of soil was possible. Mr. Gollan reports that "during the dry seasons of the year, salt-bush and other exotics indigenous to dry countries thrive fairly well in it, but the moment the monsoon begins, most exotics from dry countries fall into an unhealthy condition and die. Under careful garden culture, *Atriplex nummularia* lived here for some years, but the plant would not have lived through a single rainy season, if it had been planted in a waste piece of ground where it had to take care of itself. Acclimatization in the full sense of the term was never attained in the case of any of the species named."

An account of the tests made on the barren lands (*usar*) of the United Provinces is given in Agricultural Ledger No. 13 of 1901, the final result being that without exception all died out. A fresh set of experiments was commenced under careful supervision at Cawnpore in 1900 with the following varieties, which were carefully selected as the most suitable by the Director of Agriculture (W. H. Moreland) during his visit to Australia :— *Atriplex nummularia, A. halimoides, A. semibaccata, A. vesicaria, A. leptocarpa,* and *Chenopodium auricomum.* In most

cases the germination was very bad, both in good soil and in alkali soil. All the varieties gradually died out, the last to die being *A. semibaccata*, which was killed by the heavy rains of 1904. Three other salt-bushes, which have succeeded on alkali land in Arizona, were also tried, *Atriplex canescens*, *A. elegans* and *A. natallii*, which also failed from the same cause.

A special test of *Atriplex nummularia* was made in 1901-02 under the guidance of the Director of the Botanical Survey of India, who reports the results in the following words:—"It so happens that a few months before the Indian Famine Union memorandum was presented to the Secretary of State, I had made an attempt to introduce to India one of these salt-bushes; a brief *résumé* of the results of this attempt will be more instructive than any discursive collation of the results of former efforts in the same direction, most of which I find have already been assiduously brought together by the Indian Famine Union. The plant in question is *Atriplex nummularia*, which was chosen for renewed trial, first because it happens to be one of the most valuable of the exotic salt-bushes; again, because it is the one that in the past has given for a time more hopeful results than any other in parts of India where the introduction of such fodder is most desirable; lastly, because on this occasion I had succeeded in obtaining seed from Queensland, where the natural conditions more closely resemble those of India than do the conditions of New South Wales, Victoria and South Australia, whence previous supplies of seed had been drawn. Besides being tried at Calcutta in the Royal Botanic Garden and in the gardens of the Agri-Horticultural Society, it was tried in the garden of the Madras Agri-Horticultural Society, so as to check the germinating power of the seed. For serious experiment, the seed was distributed to be sown at Dumraon in Behar, at Bangalore in Mysore, at Gwalior in Central India, at Poona in the Deccan, at Saharanpore in Upper India. In some places the seed failed to germinate, notably at Gwalior, where the circumstance was ascribed to the great heat, but as a rule it germinated, as the seed of this species usually does, very freely: and when planted out, the

young plants progressed favourably. In Calcutta and at Madras, however, every plant was lost before the close of the rainy season, the month in which the plants perished at Calcutta being September. In localities where the conditions are typically those of the districts this experiment was intended to benefit, like Poona and Saharanpore, the plants at first throve better than in Calcutta or Madras, and all of them did not die out. The greater number, however, disappeared, so that even there the net result amounts in a normal season to the necessity for renewing the experiment at the same point in the following year."

Trials of *Atriplex nummularia* and *A. semibaccata* were also made in the dry zones of Burma, where the rainfall averages about 25 to 30 inches annually, but these also ended in failure.

Uniform failure has thus resulted in all these trials in those great tracts of India, which are characterized by a fair monsoon rainfall, but which occasionally suffer famines with the failure of this rainfall. It is unnecessary to give in detail the results of trials in the still more unfavourable tracts of heavy rainfall, such as the East and West Coasts, Bengal and Assam, which were also failures, but it has been proved over and over again that these drought-resisting plants will not survive in a tract with a monsoon rainfall. The Director of the Botanical Survey writes—"In normal seasons, as a long series of carefully conducted experiments extended over more than twenty years have shown, it is impossible to preserve alive more than a fraction of the plants, and it is necessary to exercise special care in order to ensure the survival of this remnant, while in seasons when there is any material excess of rainfall all must perish; and the experiment has either to begin with a new season where it began the preceding year, or has to be initiated afresh. If it were possible to predict a year beforehand that a particular season was to be one of abnormally short rainfall, there would be a certainty that such salt-bushes, as were sown for that year, would survive. But the sowing of such a quantity of seed of these salt fodders as would be sufficient to provide a supply of cattle-food adequate

to replace the loss of the ordinary indigenous fodders that is implied in the mere fact that the salt-bushes are to be able to live and to thrive, involves an undertaking the costliness of which would be very great. The attainment of the object in view, which is the saving of the people's cattle, would no doubt justify the cost. But there is another point to be considered. The undertaking to be adequate must involve the sowing of these salt-bushes on large areas that would normally be devoted to other crops, and only absolute certainty as to the accuracy of the forecast could justify the compulsion that the whole proceeding must involve. Even if an absolutely accurate forecast could be guaranteed, the use of salt-bushes indigenous to India rather than of those recommended by the Indian Famine Union would still be distinctly indicated. A step in the direction of this end might be taken in a systematic attempt to naturalize the Indian salt-bushes, natives of those parts of India mentioned in paragraph 3, within the parts of India now under discussion. But the very fact that, in spite of the circumstance that these districts do unfortunately too often experience seasons that are conducive to the welfare of such salt-bushes, such plants never occur naturally within their limits, is a very certain indication that success in this undertaking cannot be hoped for." Mr. Gollan expresses the same opinion that it is a waste of time and money experimenting with such exotics in any part of India where a monsoon rainfall is the normal condition of seasons.

In view of these failures in tracts with a monsoon rainfall, more interest attaches to the trials in the sub-desert area of Sindh, Rajputana and the Western Punjab, where the rainfall is normally scanty. I have only been able to secure reports of the trials in the Punjab. From 1882 to 1887, seed of *Atriplex nummularia* was distributed to several districts for growth by local officers. Owing to the usual difficulties in carrying out such trials by officers with other duties, the records are far from complete or decisive, but in 1897 a special inquiry was made as to the results which gave the following information :—Multan, some plants in existence but not used as fodder ; Rohtak, Sirsa and

Gurgaon, failures; Dera Ghazi Khan, only four plants in existence; Muzaffergarh, all plants killed by floods; Hissar, some shrubs in fair condition, the leaves of which are eaten by goats as fodder; Karnal, Jhang, Dera Ismail Khan, Gujranwala, and Montgomery, no trace of the plants found.

A fresh distribution of seed of *Atriplex nummularia* and *A. halimoides* was made in 1898 to the districts of Dera Ghazi Khan, Ferozpore, Karnal, Muzaffergarh, Jhang, Hissar, Montgomery and Gujranwala. The reports again show general failure, although some plants were raised with partial success in Hissar, Muzaffergarh and Dera Ghazi Khan. A further distribution of seed was made in 1899: in Jhang, Dera Ghazi Khan and Karnal the seeds did not germinate; in Montgomery young plants died after attaining a height of twelve inches; in the Lahore gardens all the plants died after the rains; in Gujranwala the few plants raised with difficulty also died; in Multan only two bushes were alive; in Hissar only 13 out of 200 plants survived the rains, but new plants had subsequently sprung up. A final test under careful conditions was started in 1902 in the districts of Hissar and Multan, which seemed to be the most suitable. "A selected piece of *Kallar* ground was planted in three different ways, one portion with seed, another with seedlings and a third with cuttings. Water was only applied in the initial stages of growth. The reports received are wholly unfavourable."

The experiments in the Punjab thus also ended in failure. Referring to the sub-desert area of India, the Director of the Botanical Survey of India writes as follows: "Here so far as mere moisture conditions are concerned, these exotic salt-bushes will grow. But owing to somewhat different temperature conditions they will not thrive so well as they do in their native habitats. These regions possess, however, a salt scrub of their own comprising such species as *Atriplex stocksii*, *Halocharis violacea*, *Haloxylon recurvum*, *Haloxylon multiflorum*, *Haloxylon salicornicum*, *Kochia indica*, *Salsola fortida*, *Salsola verrucosa*, *Suæda fruticosa*, *Suæda marilima*, species that are in many cases as

highly valued by the inhabitants of these parts of India as fodder plants, and with quite as good reason, as are, in their respective native lands, the plants enumerated by the Indian Famine Union. To give a specific instance, *Salsola fœtida* is, in the Punjab, Rajputana, Sindh and Baluchistan, quite as highly valued as a camel-fodder as in Central Australia is *Atriplex nummularia*, the species particularly selected and recommended by the Union for introduction into the very districts already naturally provided for with a similar plant. All the plants enumerated above possess over the species enumerated by the Union this great advantage that they are already at home and already thrive well under the conditions to which in the Indian deserts they are naturally subjected. It may be true that in such districts something might and ought to be done to extend the growth of existing and indigenous salt-bushes, at least to the extent of eliminating the less nutritious and thus leaving more room for the more valuable ones. But it is in my opinion doubtful, though in this matter I write without the advantage of close personal knowledge, whether the existing needs of such districts call for the expenditure of public money in the direction indicated. I do not, however, think it doubtful that the expenditure can only be justified if it is based on the rise and spread of local public opinion on the subject, and feel certain that such opinion can only be sound if it is evolved from within. The effect of even sound public opinion on the subject will, moreover, in all likelihood lead not to the mitigation of any existing distress but only to an increase in the quantity of stock that such districts can sustain—a point that will be considered further on and will necessarily leave matters in reality much as they are."

Experiments were also made in the United Provinces with plants other than salt-bushes. *Sorghum halepense* (Johnston grass) was recommended as an excellent drought-resister and good fodder. Sown in good soil, the root development was so alarming that it was dug up; it is a troublesome weed in the Saharanpore Gardens, where it was apparently introduced by accident, so that it could only be grown on poor sandy soil without being a danger

to cultivation. *Cytisus prolifer* (inaccurately called tree-lucerne) germinated freely, but every plant was killed off by the heat of May and June, though carefully tended. Five species of grass said to flourish in Arizona were also tried in 1902, but failed to germinate. The names under which they were received were *Pappophorum apertum*, *Pappophorum vaginatum*, *Eriocloa cuspidata*, *Sporobolus strictus* and *Boutclooa rotheriki*.

Special mention may be made of the trials in many parts of India of *Paspalum dilatatum* as a drought-resisting grass. The results are summarized by the Director of the Botanical Survey in the following words:—"It so happens that this very grass had for some considerable time prior to the submission of these papers been receiving the closest and most earnest attention of the Government of India, and to the report of the Director of the Botanical Survey of India for 1901-02 has been appended a summary of the experience with this grass in all parts of the empire. The net outcome of a sustained endeavour to introduce this highly-praised drought-resisting grass into India has been to prove that in the regions where such a plant is most required this particular plant will only grow, even in normal seasons, so long as it receives irrigation; that as soon as irrigation is withheld, it dies off. It does not in fact subsist under Indian conditions so well as several equally nutritious native grasses do, and does not under irrigation give such a large return as some other grasses, native and introduced."

Sachalin (*Polygonum sachalinese*, Schimdt), a Japanese fodder grass, said to be drought-resistant and useful for binding sand dunes, has been tried in Madras, Ranchi, Lucknow, Saharanpore and Bangalore. It failed entirely in most places; the growth was sickly, irrigation was required to keep it alive, and the yield of fodder was small.

An Abyssinian plant, known as Thæff (*Eragrostis abyssinica* Link.), was tested for some years at Lucknow, Saharanpore, Ootacamund, Coonoor, Lahore and other places. It is only an annual, and thrived best in the dry hot weather, but required free irrigation; the yield of grain was exceedingly small, and as a

fodder crop it cannot compare with others already grown under similar conditions. After trial for several years, it was abandoned as a failure.

With this experience of the past as a guide, I would strongly deprecate any further extensive trials of exotic drought-resisting plants. The only possible chance of success seems to be in arid tracts, such as Sind, Rajputana and the Western Punjab, and even in these tracts I entirely agree with the opinion of the Director of the Botanical Survey that there is much more promise in the extension of the indigenous salt-bushes and other plants than in the trial of exotics. It is certain that the introduction of drought-resisting plants, such as Australian salt-bushes, can never prove a remedy for the heavy mortality of cattle during famines over the greater part of India.

COTTON CULTIVATION AND TRADE IN THE CENTRAL PROVINCES AND BERAR.

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Early History of Government Action.

Government interference in cotton cultivation is no new thing; it can be traced back to 1788, in which year the Court of Directors ordered an annual supply of Indian cotton. Very complete accounts of the measures adopted up to 1860 are to be found in the "Cotton Handbooks" published for each Presidency in 1861, which it is unnecessary to reproduce in this article, but at the present time when the British Cotton Growing Association of the first decade of the twentieth century appears to be the natural successor of the British Cotton Supply Association of the sixties, it may not be out of place to give a brief account of the measures adopted in these Provinces as a direct result of the shortage of cotton caused by the American Civil War and of the subsequent progress of the trade.

The Cotton Department, 1866 to 1877.

A cotton department, headed by a Cotton Commissioner, was first established in Bombay, and the office of Commissioner was first held by Dr. Forbes, who had been engaged for some years in experimenting with exotic cottons. Dr. Forbes visited the Wardha district in 1866, and, as a result of the recommendations made by him, a "Superintendent of Cotton Affairs" was appointed for that district. Mr. Rivett Carnac was appointed Cotton Commissioner for the Central Provinces and Berar on the 1st September 1866, and in his first report he wrote that

"these subjects received indeed so much attention in all the districts of the Central Provinces that the Cotton Commissioner on his appointment found that the wind had been nearly completely taken out of his sails, and it was not possible for him to do much more than try and keep things on the same footing on which they had been placed by former careful arrangements." This appointment lasted until 1871, when Mr. Rivett Carnac was appointed Commissioner of Cotton and Commerce with the Government of India, a post that was abolished in its turn in 1876, for in the words of the Government of India "nothing more is now required on the part of Government with regard to cotton in India. The trade settled down and found its level after the excitement caused by the failure of the supply from America had passed away. The supply from the United States has been resumed, and there is no prospect of interruption; the Cotton Supply Association which was the primary cause of Mr. Rivett Carnac's appointment has been dissolved, and it is not probable that Indian cotton will again rise to the same importance in the English market except when other sources fail."

Mr. Rivett Carnac's instructions were that the primary object of his appointment was "the introduction of foreign staples and the improvement of the indigenous plant," and also that "it would be his duty to watch over all affairs relating to cotton, and to further, so far as might be legitimately possible, all interests connected therewith." Mr. Rivett Carnac was liberally treated in the way of staff; in 1869 he had three assistants (subsequently reduced to two) and three European gardeners in charge of cotton seed farms, in addition to the clerical and menial staff. The measures adopted by the Cotton Department may be classified as follows:—(a) The introduction of Exotics; (b) The improvement of the indigenous plant; and (c) Measures adopted for the assistance of the trade.

INTRODUCTION OF EXOTICS.

Experiments were carried out in the Wardha, Nagpur, Amraoti and Akola districts with acclimatized "New Orleans"

supplied by Dr. Forbes from Dharwar. It was not successful, and was classed, on account of its weakness, below "Hinganghats," the indigenous Wardha cotton. Egyptian and fresh New Orleans sown in Nagpur were complete failures. In spite of these failures and the high character of the local cotton known as "Hinganghats," further experiments were decided on. Both New Orleans from America and acclimatised New Orleans from Dharwar were tried again the next year, but the results were disappointing, the outturn being small and the staple weak. Mr. Rivett Carnac describes the results as follows:—"The result of this another year's experiments with exotic cotton may thus be summed up. Although the plants were treated with more care than they would be likely to receive, if the cultivation became general, they succumbed to the climate—the yield was miserably small; the staple weak and far inferior to the indigenous cotton. It may fairly be urged that the season was an unfavourable one. But, in answer to this, it might be advanced that, notwithstanding the drought, the indigenous plant did not fail us, and that both in quantity and quality last year's crop was a good one. And, as the seasons are unfortunately somewhat given now-a-days to being capricious, it appears to be a question, whether it would be wise—even if the staple and outturn of the exotic were superior to that of our "Hinganghat" and "Amraoti" cotton, which the specimens grown in our provinces have not yet proved themselves to be—whether it would be wise to be dependent for our cotton supply on this somewhat delicate stranger? At present I will not say more than that I am anxious that exotic cotton should have yet another trial; and the establishment of the Government Seed Farms in three different localities in charge of competent officers, will ensure to the further experiments the fullest advantages, and the result of the sowing will be noted at length in my next report. There is every desire to give the exotic plant the fairest of chances; and if it will only assert its superiority, I can promise that no exertions will be spared to secure its extension. But it may not unfairly be said that, as yet, it has not given such an outturn

as to justify me in commencing the long-advocated crusade against the native plant. In the meantime, the indigenous cotton will receive every attention; and I have only to add that, in regard to the exotic cotton, next to decided success I should like a really well-established failure, which might authoritatively decide the question of the introduction of the American plant, and enable us to concentrate all our energies on the improvement of the cotton indigenous to the country."

Experiments in succeeding years were no more successful and, though these experiments were no doubt carefully and conscientiously carried out, the department decided that exotics could not compete with the best indigenous varieties and to concentrate its effort on the improvement and extension of these.

Improvement of Indigenous Varieties.

At this time the most important varieties of cotton grown in the Central Provinces and Berar were:—(1) *Chanda Jari*, a cold weather variety, fine and silky, staple $1\frac{1}{2}$ inches; (2) *Bani*, sown at the beginning of the rains, fine and silky, staple about 1 inch; and (3) *Jari*, sown at the beginning of the rains, hardy and prolific, coarse staple about $\frac{3}{4}$ inch.

The best *Bani* was grown in the Wardha district, and it was this variety mixed with a considerable proportion of *Chanda Jari* which was known to the trade as "Hinganghats." In Berar *Bani* (possibly with a mixture of *Jari*) was known as "*Amraotis*" or "*Oomras.*" All the evidence goes to show that "Hinganghats" was a cotton of fairly good quality and quite suitable for use in the Lancashire Mills. Mr. Bagley, M.P., Vice-President, Cotton Supply Association, wrote: "I approve of your classification of Indian cottons, and from my own former observations can confirm your estimate of Hinganghat cotton being equal to middling New Orleans." The prices fetched by this cotton support this opinion, for it is recorded that it sold for 12*d.* a pound when New Orleans was selling for $12\frac{3}{4}d$.

With a cotton of this class ready to his hand, it is not surprising that Mr. Rivett Carnac should have made vigorous

efforts to extend its cultivation and improve its quality. To these ends large quantities of seed were distributed, no less than 700 tons being sent to Khandesh in one year; the principles of selection were vigorously preached; and seed gardens were established in nine districts, in which seed selected by officers of the department from the best fields of the Poorna valley was sown. It was soon found that this system did not allow of efficient supervision, and three seed *farms* were substituted, one at Hinganghat (52 acres), one at Amraoti (98 acres), and one at Shegaon (112 acres). They were managed by gardeners sent out from England. These farms were established mainly to grow quantities of selected seed of this indigenous cotton, but experiments with exotics, manurial tests, irrigation and various methods of tillage were also to be carried out.

In 1869-70 the area at Shegaon was increased to 230 acres and at Amraoti to 280 acres, and the Hinganghat Farm was moved to Madni. In 1870-71 these farms ceased to be exclusively cotton farms; other crops were grown and experiments with Carolina paddy, Virginian tobacco and other crops were carried out. In fact, they developed into general experiment stations. In the same year the Madni Farm was moved to Nagpur. In 1872 the Amraoti Farm was abolished, and the Shegaon Farm was moved to Akola, only to be abolished in its turn the next year. The reasons given are significant:—"I regret that I was obliged, since the close of the year, to recommend that the experimental farm at Akola should also be finally closed. The demand for outlay increased annually, while the farm paid nothing, and although the locality selected for the experiments could not have been more suitable, having, moreover, an abundant supply of water, the crops that were grown were not better, and in some instances were not so good as those grown by the ordinary cultivator in the vicinity. The experiments which extended over three years were attended with no beneficial result, nor would they, in my opinion, have ever borne fruit, because the astute Koonbee will adopt none of what we consider improved methods of agriculture until we prove to him

that we can produce better crops than he can at the same outlay."

The records to which the author of this article has had access do not give any detailed accounts of the operations of these seed farms or of the effect they produced on cotton cultivation. It must be remembered that, even when they were first established, the effects of the American Civil War on the supply of raw material were already dying away, and English cotton manufacturers were going back to their old favourite in preference to Indian cotton.

With the departure of Mr. Rivett Carnac in 1871, the Cotton Department ceased to exist, work at the seed farms was no longer confined to cotton, and official interest in this subject rapidly disappeared. It is not probable that, during the short period they were working, these farms had much influence upon cotton cultivation; and, as will be shown later on, causes were shortly to spring up which altered the character of cotton cultivation in quite another way, and which the seed farms could not have hoped to combat with success.

Measures for the Assistance of the Trade.

Of the measures taken by the Cotton Department, the first—the attempt to introduce exotics—appears to have been a complete failure; the success of the second—the attempt to improve the indigenous variety,—was perhaps doubtful at the time, and certainly no lasting effect was produced; but, in its endeavours to assist trade, the department was completely successful, and the results attained have been of lasting benefit.

In 1866 the lot of the cotton buyer was by no means a happy one; the railway* was yet young, the increase in the exports of cotton enormous; the difficulty of handling this large traffic, which was concentrated into four months of the year, was greatly increased by the fact that the cotton was not baled but was packed into loose bags called "*dokras*," thus largely

* The line to Badnera was opened on 18th December, 1865, and to Nagpur on 20th February, 1867.

adding to the bulk compared with methods now in vogue. In consequence the utmost confusion prevailed, the Railway Company were unable to supply sufficient rolling-stock, cotton lay about the railway stations for weeks and weeks, covering acres of ground, and liable to damage by rain, dust and fire. Corruption was rife and waggons were put up to auction. Even when the trains were made up, they took sometimes as long as twelve days to reach Bombay. It is only fair to the Railway Company to say that all these evils were fully recognized and every effort made to put things on a more satisfactory footing; these efforts ultimately met with success, but success would neither have been so complete nor have arrived so soon had it not been for the measures taken by the Cotton Department.

The system of cotton yards was devised by Mr. Cordery, Deputy Commissioner, Akola, and was adopted by the Cotton Department. A large plot of ground belonging to Government was marked off at each railway station, and in this "yard" the whole of the cotton brought for despatch by railway, and which the company were not prepared to send off at once, was stacked. Waggons were allotted to each owner rateably in proportion to the quantity of cotton held by him, and an excellent system of passes and checks was introduced which made it possible to form a very fair idea of the impression made upon the mass during the day by the railway company. To preserve order and system, and to protect the cotton against accident and theft, a police guard was stationed in the yard. The yards were also supplied with fire engines and buckets and tanks for water placed at regular intervals, and the police guards were practised in the use of the fire engines. Sidings were run into the yards from the main line of the railway, weighbridges were erected, and other arrangements made by the Railway Company, which materially assisted the despatch of the cotton. How necessary some such system was and how great a boon it must have been is shown by the fact that at one time the quantity of cotton in the yards amounted to 5,96,684 "*dokras*" equal approximately to 2,52,072 bales of $3\frac{1}{2}$ cwts.

Such a system was naturally only a temporary expedient; in 1868 the railway was able to handle the traffic without confusion or delay, and in 1869 the cotton yards, having done their work, were abolished. This was not only due to the smoother working of the railway, but also to the introduction of presses, which were of material assistance to the railway in its effort to ensure rapid despatch. The rapidity with which presses came into favour is illustrated by the following figures :—

Exported in	Dokras.	Half pressed Bales.	Full pressed Bales.
1866	85%	13%	2%
1869	8%	66%	26%
1879	0·6%	......	99·4%

The handicap imposed on the trade in these Provinces by the use of the *dokra*, and the difficulty of transporting cotton packed in that way, are shown in the following extract from the Cotton Report of 1868-69 :—" It may, without any unfairness, be said that, for a long time, the great bugbear of the trade was the Railway Company. Those who now pass up and down the line will not easily believe the accounts of the anxiety, the trouble and the loss, which the mismanagement of the traffic entailed in former years on the cotton merchants of Central India, and which were thus described in a letter from Mr. Lionel Ashburner, to the Secretary to the Cotton Supply Association in February 1868 :—' The next process is that of pressing the cotton. There is an hydraulic press at Jalgaum in Khandesh, and there are others in Berar, but the interests vested in the Bombay presses are so powerful that the up-country presses are seldom used, and the cotton is forwarded in bulk to Bombay. Captain Sherard Osborn, C.B., has proved that the extra cost of the carriage of unpressed cotton is equal to an export tax of £2-11-0 per ton. An agitation is now in process to abolish the small tax of 4 annas per bale for the Cotton Improvement Fund, though the larger tax, which might be avoided by the use of the up-country presses, is submitted to without remonstrance. This tax is not the only burden to which cotton is subjected by the

system of unpressed carriage to Bombay. Each railway station is crowded with acres of cotton bales waiting for waggons to carry them to Bombay: the power of disposing these waggons is in the hands of the station master, and not a waggon is loaded till the station master has been bribed. In 1866 each waggon was worth Rs. 75 or Rs. 80 to the station master, equal to a tax of £2-13-4 per ton. There are now more waggons, and the facilities of transport are greater, it is probable that prices (bribes) are lower, but the system is still in force, and is submitted to rather than interfere with vested interests. Every effort has been made by Government officials, especially by Capt. Sherard Osborn and General Rivers, to check this system of corruption, for the native cotton merchants will not co-operate in suppressing it, and the European merchants, acting as they do through natives, are obliged to submit to it: without their aid no evidence is available, and a conviction is impossible. During the weeks or months that the cotton is detained at the railway stations it is entirely without shelter, and exposed to damage from rain, dust, white ants and fire.'

"Luckily these are now all legends of the past; and it is not the least pleasing duty I have to perform, in submitting this report, to notice how entirely satisfactory the arrangements of the Great Indian Peninsula Railway Company for carrying our cotton traffic have now been made."

In addition, the department used all its influence to hasten the construction of good roads and the extension of the railway line to Khamgaon,* Amraoti and Hinganghat. The telegraph was extended to six important cotton markets, and a special wire reserved for cotton messages was put up from Bombay to Calcutta *viâ* Nagpur. Determined, but apparently fruitless, efforts were made to obtain a share of the Cotton Improvement Fund† for these Provinces. The Cotton Frauds Act was extended

* The Khamgaon branch was opened in March 1870; the Amraoti branch in February 1871; and the Hinganghat branch in December, 1875.

† Raised by a tax of 4 annas a bale in Bombay.

to Berar but not to the Central Provinces. These measures have had far-reaching results, and it is not too much to say that the trade owes many, if not all, of the facilities it enjoys to-day to the exertions of the Cotton Department of forty years ago.

Results in other ways there are none, and as far as the introduction of exotics and the improvement of the staple of indigenous varieties are concerned, the department might never have existed. Nevertheless the history of its operations contains many valuable lessons, which should be carefully studied by those engaged in the similar problem to-day.

Changes in the Character of Cotton Cultivation and Progress of the Trade.

The progress of cotton cultivation and trade is shown by the following figures :—

	Area in acres.			Exports in bales (400 lbs.).
	Central Provinces.	Berar.	Total.	
1866	598,801	1,238,966	1,837,767	271,000
1905	1,586,000	3,197,900	4,783,900	1,173,002

For some years after 1866 the increase in area and exports was fairly steady, but then the fall in price began to tell. In 1876 the price of Middling Uplands ($27\frac{1}{2}d.$ in 1864) had fallen to $6\frac{1}{4}d.$ a pound. The variations in the area are more marked in the Central Provinces than Berar ; in the latter Province the area approximated to 2,000,000 acres for a good many years ; in the former in 1888 it had fallen to 535,199 acres compared with 761,037 in 1874. The fluctuations in exports do not correspond with the variation in area ; for instance, the exports in 1888 for the first time amounted to over 400,000 bales, while the area in 1887 was smaller than usual. This is of course natural, for the quantity exported depends not only on the area sown but on the yield per acre. Up to 1900 there is not much to note ; the fluctuations appear to be small and due to the character of the

seasons and the rotation of crops, but from that year onwards there is a most remarkable change, as the following figures show :—

	Area in acres.			Exports.
	Central Provinces.	Berar.	Total.	Bales.
1900-01	1,004,812	2,521,651	3,526,463	579,826
1901-02	981,342	2,689,201	3,670,543	1,040,812
1902-03	1,136,431	2,765,635	3,902,066	929,771
1903-04	1,293,000	2,851,000	4,144,000	914,314
1904-05	1,484,000	3,069,000	4,553,000	968,864
1905-06	1,586,000	3,197,900	4,783,900	1,173,002

This extraordinarily rapid development has been accompanied by other changes no less remarkable. In a former part of this article it has been noted that in 1867, 700 tons of Hinganghat seed were sent to the Collector of Khandesh. This was done because the Collector, Mr. Ashburner, discovered that the cotton grown in that district had in recent years been to a large extent supplanted by a coarse short staple cotton said to have come from the Nerbada valley. Mr. Ashburner took vigorous steps to stamp out this variety, and succeeded in doing so for a time. But in 1873 this variety (now commercially known as "Old Khandesh"), owing indeed to Mr. Ashburner's energetic action in Khandesh, was introduced into Amraoti, and on account of its hardiness and large outturn, found immediate favour. Its introduction was viewed with great alarm by the trade, and the Berar authorities went so far as to prohibit its cultivation, but in spite of prohibitions, in spite of a fall in price, the cultivation of this variety steadily increased. In 1880 the Manager of the Empress Mills, Nagpur, pointed out its rapid increase in popularity and said that the extension of this class of cotton would be nothing less than a calamity both to the cultivator and to the trade. In 1885 and 1891 further representations were made, and it was roundly declared that the trade was going to ruin. The apprehensions excited by the spread of this variety are well illustrated in the following extract from a letter of the Manager of the Empress Mills, dated the 1st June 1880 :—

"The publication in the *Times of India* of the 29th ultimo of the

correspondence, between the Government of Bombay and the Bombay Chamber of Commerce on the cultivation of cotton, induces me to have the honour of drawing your attention to the same subject, as regards these provinces.

"For the last three years, the cotton grown locally, as well as in the Wardha district, has been gradually deteriorating in quality, owing partly to bad season, and partly to the use of inferior cotton seed or of a mixture of inferior with superior seed. Besides this, a kind of seed is used in Nagpur and places adjacent, which produces what is called the 'Jurry' cotton. The cultivator has been sowing it because the yield has been greater, weight for weight, than that of what is known here as 'Bunni' cotton. It is said that the seed is foreign and was at first distributed by Government officers, possibly led away by the comparatively large quantity of cotton produced and by the whiteness of its colour. But its staple is short, thick and woolly, and unsuitable for spinning purposes. It resembles much what is known as 'Vilayati' cotton in the Amraoti market and about which there had, a few months ago, been much discussion among the cotton merchants of Bombay.

"On the other hand, the Bunny cotton consists of long, fine, silky and strong staple, and well adapted for manufacture especially by machinery. The Jurry cotton seems to have been sown to such a great extent, that it is now almost impossible to get pure Bunni seed; and there is not a single bale of cotton, offered as Bunni, which has not more or less of Jurry mixed with it.

"This evil is likely to spread over the Wardha district. As the quality of the Jurry cotton is becoming known here, the sale of the cotton is getting limited, and consequently the growers have to take it to Wardha, where this season we met with a large quantity of it. As all cotton brought into the Wardha market goes by the good name of Hinganghat, this Jurry cotton passes as Hinganghat, and the consequence will be that in a short time, when its real nature is known, the Hinganghat cotton will be looked upon with suspicion. You are, no doubt, aware that this season even the proper Hinganghat was classed as of a lower

standard than usual by the Liverpool merchants. But when such cotton as I have been describing goes up as Hinganghat, the effect will be worse. This is not all. It seems most likely that the Jurry seed will find its way to the Wardha district and get mixed with Hinganghat seed, if it has not already done so. In that case, it will be quite out of the power of the cultivators in that district to eradicate the evil afterwards. I am told that these cultivators here who are anxious to sow only Bunny, cannot do so because of the difficulty of getting pure seed."

One very remarkable point should be noted in this letter,—*viz.*, that the coarse "old Khandesh" cotton was known in Berar as "Vilayati," was said to have been introduced by Government and was supposed to be American. Thus by the irony of fate the very cotton which the Government endeavoured to eradicate became known as one which they had introduced. Could confusion of ideas go further?

As regards *Vilayati Khandesh*, Dr. Hume remarks that it is very indifferent cotton and came to Berar principally, he believes, because Mr. Ashburner, Collector of Khandesh, forbade its cultivation in Khandesh. He adds :— "The subject of cotton in Berar is one that requires immediate supervision. It has been left in the hands of ignorant Koonbees, who have no thought for the morrow, but grow whatever pays best at the time. The Khandesh variety is being grown largely to the ousting of the other varieties, to the most certain ruin of the Berar cotton trade. At present they get from Vilayati Khandesh an early crop, also a large one, getting three or four pickings instead of two or three as they get from indigenous cotton. They get Rs. 3 or Rs. 4 a bale less in price than for the indigenous cotton, but the greater bulk compensates, and much more, for this small loss. But this apparent prosperity will be shortlived, for it is only by mixing this Vilayati Khandesh cotton with the indigenous cottons that merchants can get it accepted in Bombay, and that mixing cannot be carried to a greater extent than a third of the quantity with *Bani* and much smaller proportion with *Jari*. When this Khandesh cotton has succeeded in ousting the *Bani*

and *Jari*, there seems every prospect of extensive distress and ruin."

But the Government of the day took no decided action; they held what appears to be the only sane view, *i.e.*, that the production of cotton is governed by the ordinary laws of supply and demand and that the ryots will grow what pays them best. Under these circumstances Government interference was not only impossible but unjustifiable. The views of the Government of India were expressed in the following words :—"In reply, I am directed to say that, after giving the subject of your letter its careful attention, the Government of India has come to the conclusion that any attempt on the part of the State to make the Berar cultivator grow one class of cotton when his immediate interests prompt him to grow another, is almost certain to end in failure. The measures taken in Khandesh have not been permanently successful any more than Berar. The steps taken by Mr. Ashburner in 1876 succeeded at the time, but as soon as the vigorous measures to which he had to resort ceased with his departure from the district, the cultivators of Khandesh returned to the inferior and indigenous variety of cotton. Writing in 1882, Mr. Probert, the Collector of Khandesh, was obliged to confess that all his endeavours during six years of office to discourage the cultivation of the inferior cotton had been practically fruitless."

Since 1891, the cultivation of this kind of cotton has steadily increased; no accurate statistics are available, but there is no doubt that it is ousting the longer staples. Not only is the area under the finer variety of *Bani* steadily shrinking but, except in a few places where local conditions are greatly in its favour, *Bani* is very impure. Generally speaking, it contains 15 to 20 per cent. of "old Khandesh." This mixture may be due to the conditions of trade at the time "old Khandesh" was introduced; it was then grown merely to mix with better varieties, which practice may have resulted in the mixture of seeds of various varieties. Unfortunately no figures showing the areas under long and short staple cotton are available for recent years, but the Director of Land Records estimates the proportion of long staple at 20 per

cent. On that assumption the following comparison is instructive. It can only be given for Berar; figures for the Central Provinces are not available.

1878-79.		1905-06.	
Bani (long staple)	1,558,426 acres.	Long staple	639,580 acres.
Jari (short staple)	629,653 ,,	Short staple	2,558,320 ,,
"Old Khandesh" (short staple) ..	14,805 ,,		
Others	5,005 ,,		
Total ...	2,207,889 acres.	Total ...	3,197,900 acres.

Thus while the total area under cotton has increased by 990,011 acres, that under long staple has fallen by 918,846 acres, and it is not too much to assume that these figures represent an increase of 1,908,857 acres under "old Khandesh." It is impossible to ignore the significance of these figures; they show clearly that in the opinion of the cotton-growers the cultivation of short staple cotton is more profitable than that of long. The reasons are that the short staple gives a larger outturn of uncleaned cotton per acre and that cotton contains a larger proportion of lint; the percentage of lint to seed is so much larger than in the case of long staple that the higher price obtainable for the latter is insufficient to enable the cultivator to reap an equal return; moreover, the short staple is a hardy, vigorous plant that gives a more certain crop.

Many who have dealt with this subject seem to have laboured under two misapprehensions:—(1) that long staple cotton is necessarily more profitable than short; (2) that short staple cotton has no market of its own and is grown only for the purpose of adulterating finer varieties. Present conditions in the Central Provinces and Berar clearly prove that the first assumption is erroneous. *Bani* will not, except under specially favourable conditions, yield so large a profit as the coarse varieties. Time has shown the second assumption to be equally mistaken. This was recognized twenty years ago, when Mr. Cordery wrote—"I have the honour to forward what appears to me to be a careful and able report from the Officiating Commissioner upon

the manner in which the Province of Berar is affected by the large and increasing admixture of an inferior variety of seed with that which produced a longer staple of cotton.

"If, as Mr. Ridsdale asserts, the new crop has created a market of its own with a designation known in Liverpool and commanding a sufficient profit, there can be no need for any action whatever. The question has, of course, been represented in a very different light by other officers; but the conclusions drawn by the Officiating Commissioner would appear to be more in accordance with the probabilities deducible from the recent extension in the growth of this variety than those based on the statements of traders disappointed in not finding the better variety which they desire to purchase. In such cases the term "adulteration" is not truly applicable. There is no concealment on the part of the cultivator, and the buyer is not deceived. The substitution of an inferior staple for one which formerly enjoyed a better reputation and a larger price must, under these circumstances, be held to be due to natural causes, against which it is useless to contest."

The advocates of the long staple still contend that it can be grown at a profit, and that the reason why it is now less profitable than short, is that it is not grown pure and that in consequence the lint never fetches the price its quality would bring if pure. This is also probably a fallacy, that is to say, it is a fallacy to suppose that *Bani*, even if pure, can take the place of short staple *everywhere*. In places peculiarly suitable to its growth, *Bani* is, and will probably continue to be, grown; in others, where it does not flourish so well, it has been ousted by the short staple, and there is little hope of its regaining its place. It must not be forgotten that the large increase in the area under cotton in recent years is coincident with the spread of the short staple variety. The great increase in prosperity, an increase which cannot fail to strike every resident of these Provinces, is due largely to the short staple cotton and not to any improvement in existing long staple varieties. In 1878-79, when the area under cotton in Berar was 2,207,889 acres, it was thought that the

limit of cotton cultivation had been reached; in the light of present figures (3,197,900 acres), this conclusion appears unsound, but it is not so absurd as it looks; it was doubtless arrived at upon the assumption that *Bani* and the old Berar *Jari* would continue to be the chief cottons grown and, had this been so, it is probable that the conclusion would not have been very far wrong; indeed, for ten years the area of 1878-79 was not exceeded. The large increase in recent years is probably due entirely to the extension of "old Khandesh," which will grow and flourish in places where the finer cottons would either fail or cease to yield a profitable return.

The most important cottons now grown in the South of the Central Provinces and in Berar are:—(1) *Chanda Jari;* (2) *Bani;* and (3) *Nagpur Jari*, or, as it is known in Berar, "*Kata Vilayati.*" The old Berar *Jari* appears to have completely disappeared. What is known as Nagpur *Jari* (which will hereafter be referred to simply as *Jari*) appears to be identical with the Berar *Kata Vilayati*, and is a mixture in which "old Khandesh" largely predominates.

Mr. Fletcher in his interesting article in the October number of the Journal (Vol. I, page 351 *et seq.*), raises several important questions; he asks, first, if *Bani* has deteriorated; second, if the decline in the area under *Bani* is due to deliberate mixing of *Jari;* third, if, owing to this mixture, it is now impossible for the cultivator to procure pure *Bani* seed; and fourth, is the cultivation of *Jari* really more profitable than that of *Bani* grown at its best, or is it so now because *Bani* has deteriorated or is grown impure.

Bani probably has deteriorated *in places;* the extension of cotton cultivation in the sixties led to the distribution of large quantities of *Bani* seed, and attempts were made to grow it in soils and climates not entirely suitable.* Under such conditions

* "In regard to the results of the Hinganghat seed in the Berars, I regret that I am unable to speak to its general success, and I think, I see now, with my more intimate knowledge of the country, what I did not quite realize before, that, owing to the physical peculiarities of the Berars, good reasons may exist for this seed proving a success in some localities, and yet not

it is safe to assume that it has deteriorated, but grown in the old strongholds of the plant it is said to be capable of spinning up to 40's and is probably as good as it was 40 years ago.

The second and third questions have been partly answered in a former part of this article; *Jari* is not now grown merely for adulteration purposes, it has a market of its own with a very profitable export trade to the continent of Europe for admixture with wool, and it is grown from choice and not necessity. The Berar cultivator is not dependent on ginning factories for his seed, but in the great majority of cases selects his own. In selecting he chooses the whitest, largest and coarsest bolls and throws away the rest; he is selecting for yield and is fixing the old "Khandesh" type as the one he wishes to grow. *Jari*, as sown in these Provinces, is a mixture of the following four varieties:—*Gossypium neglectum malvensis*, *G. neglectum vera*, *G. neglectum rosea*, and *G. neglectum rosea cutchica*. Under the system of selection practised by the ryot, the finer varieties, *malvensis* and *vera*, are deliberately thrown away, and the coarser *roseas* retained. This accounts for an important change that has occurred in the cotton supply during the past seven years. The local mills complain of a great deterioration of staple, that whereas seven years ago *Jari* cotton was suitable for counts of 16's to 20's it will now barely spin 10's; and that this has been accompanied by a steady increase in the percentage of lint to seed, which has risen from an average

answering in other parts of the Province. And this rather confirms the view I have already expressed of the importance of trying to improve, by seed gardens and other measures, the indigenous produce of each tract, the suitability of which to the soil and climate has been established by long years of local experience. In some parts, especially in the east of the Amraoti district, where the soil assimilates to that of the Hinganghat country, the seed answered well and will be sown again this season. The plants of the two tracts are indeed of the same variety, but the interchange and the importation of the seed of the plant grown in the more favoured lands of Hinganghat did good. In the almost unfathomable black cotton soil of the Poornah Valley the seed did not answer, and there is reason to believe that the statement of the people, that the Jurree plant there grown is the class of cotton best adapted to the peculiarities of the soil, is correct; and the importance of making further experiments will not be lost sight of. Attention will be given to improving the Jurree seed which hundreds of years of cultivation have proved to be well adapted to the rich land of the valley of the Poornah."

of 32% to 40%. The deliberate selection of the *roseas* explains these remarkable changes.

Reliable estimates of the outturn per acre do not appear to be available, but the following figures (obtained after much inquiry), if anything, favour the case for *Bani* :—

OUTTURN PER ACRE.

	Uncleaned cotton	Lint.	Value.
Jari	... 350 lbs.	115 lbs. (33%)	=488*d.* @ $4\frac{1}{4}$*d.*
Bani	... 250 lbs.	70 lbs. (28%)	...

Thus, if the ryot is to realize the same profits from *Bani* as from *Jari*, the former must be worth about 7*d.* a pound. That it certainly is not. The Manager, Empress Mills, Nagpur, classes *Bani* as equal to middling American, priced at 5·81*d.* a pound. He says that it will spin up 32's easily and 40's with difficulty. The American cotton imported by him for spinning into 40 counts costs 6·41*d.*, so that even if *Bani* were equal to this in quality, it still could not compete with *Jari*. These figures are very strong evidence that there has been little if any deterioration in *Bani* when grown at its best, for the Manager now classes it as equal to Middling American, and in 1868 when New Orleans was selling at $12\frac{3}{4}$*d.* a pound, "Hinghanghats" fetched 12*d.* The opinion of Mr. Bagley, Vice-President, Cotton Supply Association on "Hinghanghats," given in 1867, has already been quoted in this article. *Jari* is popular because of its hardiness and certainty, its heavy yield (1,000 lbs. seed cotton giving 330 lbs. lint per acre is known), the ease with which it is picked, and the fact that it ripens early and so can be placed on the market in October. It must be remembered that it has twice triumphed over longer staples in Khandesh, for Mr. Ashburner's efforts to eradicate it were successful only as long as he was there to enforce his vigorous measures. It attained considerable popularity in Berar at a time when the exertions of the Cotton Department were fresh in everybody's memory, and when there can have been no difficulty about getting pure *Bani* seed. It is now firmly established in popular favour and, under all these circumstances, it is difficult to resist the conclusion that, in this variety, the ryot of

these provinces has found his most profitable and certain crop. Thus, there appears to be small prospect of substituting long staple for short staple cotton in these provinces and, as long as the demand for the short staple exists, the ryot would gain nothing by doing so.

Great changes have come over the world's cotton trade, and these changes appear to favour the short staple. Mills are increasing rapidly on the continent of Europe and in Japan and, as these mills are generally fitted to spin low counts, they require short staple cotton. The following figures illustrate the position :—

	No. of spindles.		Annual consumption in bales.	
	1868.	1903.	1868.	1903.
Great Britain	34,200,000	48,000,000	3,000,000	3,356,000
Continent of Europe	15,000,000	34,000,000	2,000,000	4,586,000
India ...	390,500	5,000,000	77,400	1,171,000

In addition we now have some 2,000,000 spindles in China and Japan. These figures show clearly why Great Britain is no longer India's chief customer; there are also other causes, notably the opening of the Suez Canal, which account for the decline in exports to Great Britain, which are now a mere fraction of what they once were. The exports of Indian cotton to Great Britain, which amounted to 1,370,000 bales in 1868, have fallen to 106,432 bales in 1906. Thus, conditions in Great Britain have little direct effect on the present Indian trade, and it is the conditions in other countries which will, in the end, determine the fate of the short staple.

In the Central Provinces the increase in the area under cotton is most marked in the Nagpur and Nerbada divisions; indeed in the others there is a decrease. The figures are :—

	1866-67.	1904-05.
Nagpur	281,332 acres.	882,390 acres.
Nerbada ...	121,481 „	533,654 „
Jubbulpore	74,573 „	45,305 „
Chhattisgarh	100,274 „	33,674 „

Chhattisgarh, owing to its land-locked position, was probably the last to feel the effects of the keen demand for cotton in the

sixties; the area, however, rose to 200,000 acres in 1878-79. Much of the cotton grown there was probably of inferior quality and was retained for local consumption. Even this demand fell off with the extension of the railway to this tract; the line was opened in 1890, and by 1894 the area had fallen to 15,382 acres; the local products were probably ousted by imports, as shown by the following statistics of the imports into this division:—

	Piece-goods.	Twist and Yarn.	
		European.	Indian.
	Maunds.		
1874	4,661	......	......
1883	7,693	1,026	2,606
1889	9,752	2,337	3,105
1894	27,068	7,256	18,802

The increase following shortly after the opening of the railway is remarkable. No such conclusion can be drawn in the case of the Jubbulpore division, where the area under cotton has never been of great importance. In the Nerbada division, the Nimar district is the most important, and stands third in the list of cotton-producing districts; the area rose from 25,909 to 298,387 acres.

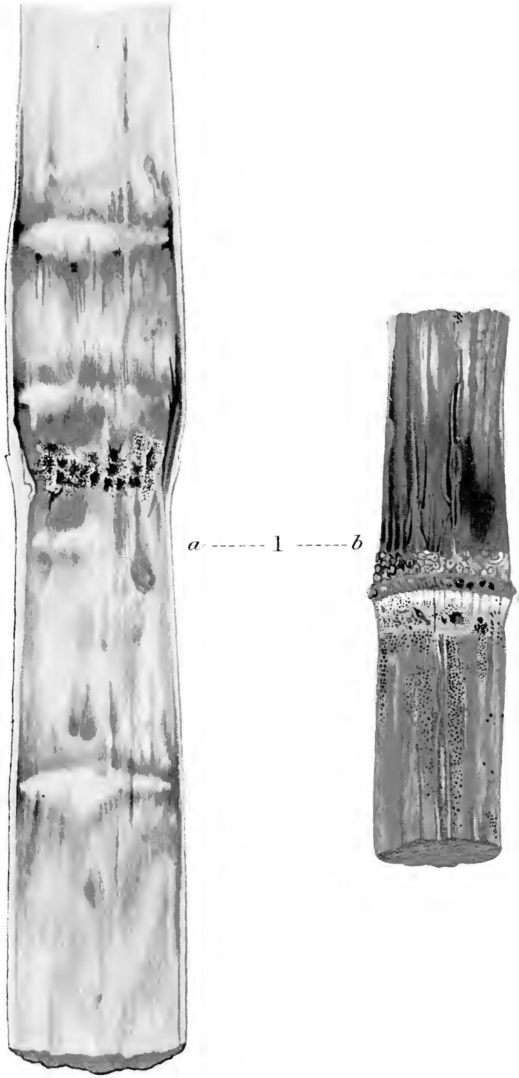
In Berar, the increase is general, the figures for Basim being the most striking:—

	1866-67.	1904-05.
Akola	406,862 acres.	743,268 acres.
Amraoti	182,183 „	715,127 „
Basim	62,241 „	360,059 „
Buldhana	195,113 „	421,768 „
Ellichpur	309,172 „	348,591 „
Wun	131,161 „	478,211 „

The great increase in material prosperity with which these provinces have been favoured in the last few years is largely, and in the south of the Central Provinces and Berar almost entirely, due to the cotton trade. Its effects are very marked: wages have risen (7 annas a day is paid for unskilled labour in Akola), the price of food-grains in spite of a good autumn harvest and the prospect of excellent spring crops remains high, fodder is

obtainable with difficulty, and as a consequence carting charges have risen. In the Nagpur country there was an excess of 390,402 maunds of food-grains imported over those exported, and in Berar the excess was 1,388,370 maunds. Forty-eight ginning factories have been erected in one year in Berar. These changes will have far-reaching effects, but it would be out of place to discuss them here. The land revenue of the provinces is Rs. 17,298,959, and the value of the cotton *exported* in 1904 was Rs. 84,707,123, which does not support the view of those who see in the land revenue an exorbitant and oppressive tax and the real cause of all famines.

PLATE XI.



CHHOTALAL D. SHAH. pinx. West, Newman chromo.

THE SELECTION OF SUGARCANE CUTTINGS.

By E. J. BUTLER, M.B., F.L.S.,

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The losses caused by diseases of the sugarcane are yearly attracting more and more attention in every cane-growing country, and it is gradually becoming recognized that the question of their prevention is one of the chief problems that sugarcane planters have to face. This is not less the case in India than elsewhere, for a number of sugarcane diseases are already known in this country, and one of them—red rot or red smut—is the cause of very great damage to the crop in many places.

Red rot is caused by a minute fungus, *Colletotrichum falcatum* Went, which grows in the cane pith, producing a red discolouration of the latter. Plate XI, Fig. *a.*, shows an infected cane split longitudinally. The red markings are peculiar in some respects, and are sufficient to enable any one with a little practice to recognize the disease. The first point that will be observed is that the discolouration does not affect the whole of the pith uniformly. It has a tendency to appear in sharply marked streaks or lines, these indicating, for the most part, the fibres which run along the pith and contain the water vessels of the plant. The colouration is usually greatest at the nodes or joints, and less, but still visible in streaks, between the joints. Here and there white patches surrounded with a red ring are visible, and it is noticeable that these patches extend across the cane, not along it. None of the other injuries to cane, which cause reddening of the pith, produce these white patches, and their presence in any cane is an infallible sign that it is attacked by red rot.

The diseased cane figured in Plate XI, Fig. *a.*, is an early case, while the pith is still juicy. Later on it dries up and turns dark

grey or mud coloured. In the first stage there is not usually much indication of the disease on the outside of the cane, which is still full and rigid. When drying up occurs, however, the cane collapses between the joints and shows long wrinkles where it has fallen in; at the same time it becomes soft or brittle and can easily be bent or broken off. Early in this second stage a number of little black dots appear on the surface (Plate XI, Fig. *b*), and the fungus comes to light. These dots, which are the spore beds, collect chiefly at the joints, but also appear in the wrinkled parts between. They are often rare or hard to find, and are so small that the use of a lens is necessary to see them clearly.

The spores that are formed in these black spore beds can germinate if sown on nutrient jelly or even in moist earth, and produce a mould-like growth of the fungus on the surface. A little of this inserted into the pith of a healthy cane can set up red rot and quickly lead to the discolouration of a small patch of the neighbouring pith. Hence the fungus is a parasite which can live in the soil or on decaying leaves in the fields, when it has no sugarcane to feed on. Just how long it can survive away from the cane is not known, but there is evidence to show that, ordinarily, three or four months is enough to cause its disappearance from the soil.

It is, of course, evident that the spores, instead of falling on the soil, may lodge on healthy canes near by and infect them directly. This would be extremely common, no doubt, but for the fact that the cane rind offers a barrier which the fungus is unable to pass. Hence to reach the pith and set up red rot, it must fall on some broken or damaged part of the rind. Unfortunately, as every one knows, the cane rind is frequently damaged, either by the holes of borer insects, or by cracks that form naturally in many varieties while the cane is ripening. If the spores fall into these wounds, a small patch of red rot is set up, sometimes of sufficient severity to kill the particular cane affected.

In some parts of India, as in the Godaveri Delta, this death of single canes in a stool, from the entry of the parasite through a wound, is common. Most cane fields show a number of such

PLATE XII.

cases. In other parts of India as in Behar, it is not so common. This is possibly due to the drier climate of these parts after October when the spore production of the fungus begins. It is extremely rare in Behar to find any spores before November, and it is possible that, at this time, the natural conditions are such that, even should spores be blown on to a wounded cane, they cannot germinate or grow with sufficient vigour to cause the death of the cane. If so, then the past year must have been abnormal in some respects, for a large number of wound infections occurred at Pusa, though as previously said they are not usually common in this part of the country.

Now, there is another aspect of the matter to be considered. Sugarcane is usually grown from sets or cuttings, not from seed. It is evident that amongst these cuttings some will have the rind broken by wounds. Some of these damaged sets will have been infected by red rot as just described, and the set will be planted out *with the parasite in it.* Further, if infection of the wounded cane has occurred sufficiently early in the season, the fungus may have extended two or three feet along the cane (producing always the red discolouration of the pith), and not one, but three or four, diseased sets may be planted from a single infected cane. Of course, if the infection were very severe, the cane would be dead at planting time and would not be used for seed; but a large number of the canes at planting time will be just sufficiently infected to show the discolouration, but will still look healthy externally and be quite juicy, so that, unless the reddening is accepted as a danger signal, they will be planted.

What this may result in is shown in Plate XII. Alternate rows of reddened and unreddened sets of a Madras cane, known as *yerra*, were sown at Pusa in 1906. The unreddened sets germinated well and gave a promising-looking crop. The reddened ones on the other hand germinated badly, and even of those that did come up, a number died in the following two or three months. On digging these up and examining them, it was found that the parasite had grown into the new shoots and killed them. It is probable that many of the sets which fail

to germinate, and which are usually said to be killed by white-ants, are really killed by red rot, and the white-ants are merely followers that feed on the dead cane.

Very often it happens that the red rot fungus, though present in the planted set, fails to kill the young shoots on germination. Why this should be it is difficult to say, as it is one of those mysteries connected with the struggle between host and parasite, about which we are still very much in the dark. Sometimes the parasite gets the upper hand and kills the young plant: sometimes the young plant is too strong for the parasite and keeps it in check. However, even in this latter case, the parasite is not got rid of, but merely remains dormant in the stool. As the cane begins to contain an appreciable quantity of sugar, the fungus resumes its growth, and will be found flourishing very vigorously about September or October in Behar. Hence, about this time, numbers of cane clumps begin to show signs of disease. The fungus is now attacking the most vital part of the cane, the base of the stool, and spreading from here up into each individual cane. One after another each cane in the stool withers, the oldest first, until the whole clump is destroyed. This is the form of the disease with which every planter in Behar is familiar, and the point which I wish to emphasise is that spore infection in the particular year has nothing whatever to do with it, for when it begins, there are scarcely any spores about; it is the result of planting sets containing the parasite already within them.

It may be asked, in regard to this, whether spores from the soil may not attack the growing crop. Apart from the fact that the spores do not live long in the soil, this has been shown by another experiment not to occur commonly. Pieces of land that had borne a diseased crop the previous year, and consequently were plentifully charged with spores, were replanted with healthy seed. Even when the variety used was one that is subject to the disease and was, therefore, not a naturally immune kind, no appreciable disease resulted.

The effect of rattooning diseased cane may be anticipated from what has been said. Where disease has been severe, a large

number of the stools left in the ground after cutting the crop, will contain the fungus. This has been proved by actual observation. When the second crop grows from these stools, the fungus may, as already said, remain dormant for some months. But, as the cane matures, the parasite resumes activity, and gradually clump after clump withers. Plate XIII shows an extreme case of this. The diseased variety *yerra* was rattooned at Pusa along with the other varieties in 1906. The previous crop had been very badly diseased. In spite of this the rattoons grew fairly well at first. During the monsoon they began to wither, and by December the condition shown in Plate XIII was seen. The variety occupied a long narrow plot in the middle of the other rattooned varieties. The whole of it died out, while the neighbouring varieties remained quite healthy, so that the appearance was as if a road had been cleared right through the cane field.

Now, all this makes it clear that the examination of the cuttings for red rot at the time of planting is a very important matter. Almost every cane field contains some plants attacked by red rot. It is not possible absolutely to prevent its appearance. The spores cannot all be destroyed, do what we may. Disease in plants, as in man, can never be entirely exterminated, but it can be checked and prevented from becoming epidemic. That is all we require to aim at—to keep it down within reasonable limits. Of all the precautions which can be taken to check cane diseases, the most important is the selection and examination of the seed. It should be as essential a part of the routine practice in planting as the preparation of the soil.

To this it may be objected that in some places, and with some cane varieties, there is no disease, and seed examination for red rot is just so much waste of time. This is a very dangerous argument. It is extremely difficult to say, without examining the sets, whether disease is present or not. No variety of cane, so far as is known, can be said entirely to withstand it. It is true there is a great difference in the liability of different varieties to infection. Certain races of cane seem to become so impregnated with disease that it is hard to get any of them free from it, while

others have so little that a careful search is necessary to find cases. But, even in the latter kinds, unless all diseased sets are weeded out at planting time, the number increases year by year and may become considerable. Sometimes, too, it happens that a bad season so weakens the constitution of a variety, or so increases the number of spores, that cases of infection through wounds become numerous, and the succeeding crop will have to be very carefully handled to avoid an epidemic. The examination of sets is an insurance against disease, and even if wasted for several years, is a precaution that cannot be neglected without probability of disaster.

The attacks of red rot are very insidious. An instance of this may be given from my own experience. A race of cane known to be very generally infected was grown on a large estate. In spite of its general failure elsewhere, it gave for some years good crops and no danger was anticipated. In 1905 the fungus must have accumulated considerably and conditions then became favourable for its action. As a result, the very large acreage under this variety gave scarcely twenty per cent. of a full yield. The loss was thousands of pounds and might have been avoided if the presence of the disease had been detected by inspection of the sets. Mr. Barber has described, in the account of the Samalkota Sugarcane Farm, contributed to the first number of this journal (Vol. I, page 45), how successive canes have held favour in the Godaveri Delta during the past forty years, each in turn growing luxuriantly and bringing wealth, but after a few years becoming diseased and causing widespread loss. As a result of bad cultivation and neglect of seed selection, each cane variety in turn became thoroughly infected and had to be abandoned.

In selecting seed for cane-planting the first point to be considered is the selection of the variety. In this the past history of the cane must be taken into consideration. I have already given an instance to show how dangerous it is to grow a variety from stock known to have been seriously infected, even though the crop may be promising for the first few years. Only seed from a variety which is known to be practically free from

PLATE XIII.

disease, and to have been so for some years, should be selected. On large estates it is unquestionably best to be self-contained in the matter of seed supply. When starting a new plantation or in small estates, this is often not possible, and seed must be obtained from outside. If this is necessary on a large scale, care should be taken to select a locality as similar as possible, as regards soil and climatic conditions, to that where the cane is to be grown. Sugarcane appears to be particularly susceptible to change of conditions, and the introduction of large quantities of seed from a locality with a different climate and soil is liable to lead to deterioration, at any rate temporarily. This does not affect nursery cultivation. There is no possible objection to the introduction of new varieties on a small scale, in fact it is highly advisable to do so wherever feasible, and the maintenance of a nursery for the experimental cultivation of promising varieties is strongly to be recommended. The best of attention should be given to the nursery crop, and as soon as a variety has been tested and found satisfactory, it can be increased on a field scale, a succession of healthy seed being thus brought forward into cultivation. In introducing new varieties from abroad, it should be remembered that several of the cane diseases of other countries do not occur in India, and nursery cultivation on a small scale is absolutely imperative in this case, so as to allow of the prompt destruction of any variety which shows signs of disease.

In harvesting the seed cane much trouble in the later part of the operations can be saved by leaving out all diseased plants or patches. Some disease is almost sure to be found at harvest time, so undesirable looking canes should be left behind. This will, undoubtedly, save time and expense later on. Rejected plants may be crushed if they are worth it or, if not, they should be collected and burnt. They should on no account be left standing or ploughed in, as old dried-up canes often contain large quantities of the fungus which is capable of remaining alive in them for many months.

Where disease is prevalent, it is probably better to plant tops than cuttings from the whole cane. From the ordinary

plantation point of view, indeed, the opinion is held in many cane-growing countries that tops give the best crops. With this I am not so much concerned here as with the question of the relative freedom from disease of tops as compared with whole cane cuttings. It is well known that the top part of the cane is poorest in sugar, and it is also better protected by the leaf sheaths, which completely cover the upper joints. It is, therefore, at least probable that these upper joints are less commonly attacked with red rot, and, though no comparative experiments have yet been carried out to determine this point, the probabilities are that, from the disease point of view, the tops furnish the best seed.

The general practice in India is, however, to plant cuttings obtained from the whole cane. These are cut into lengths containing, usually, three joints. The preparation of these should be entrusted to experienced men, as it is important for several reasons that the ends should be clean cut and not shattered. In inspecting the cuttings, the ends are the points chiefly requiring examination, and this is much easier with a clean cut surface than with a jagged one. Besides, it is very important that the part left between the end joint and the cut should be undamaged as far as possible. This is the weak point of the cutting, and the road through which not alone several parasitic fungi, but also white ants, attack the cane. If not clean cut, rotting sets in and, if the shattering at the end be considerable, will reach the bud, before it has become independent of the set, and cause its death. Hence it is very important that the cutters should be experienced at their work.

The cut sets at Pusa are collected by boys into bundles of ten or fifteen sets, which are then inspected at the cut ends before being placed in baskets to carry on to the field. In the inspection the main point to be examined is the presence of any suspicious discolouration of the pith. Any sign of reddening of the fibres should be taken as an indication of the possible existence of red rot. In most cases cultures made from the pith of sets showing reddened fibres at the ends give a growth of the red rot fungus. Sometimes other parasitic fungi are concerned, and also

insects. But in any case it is necessary to reject all cuttings with reddening at the ends. Borer holes should also be looked for, as bored sets sometimes contain the fungus in the immediate neighbourhood of the hole, while apparently healthy at the ends.

The inspection of the sets can be carried out by any reliable overseer with very little practice. There has never been any difficulty at Pusa in training men to do it well. Even the cutters themselves, after a time, become fairly careful in rejecting any cutting which shows signs of injury. The result has been that at Pusa we have not had any general disease, except in the case of the variety *yerra* previously mentioned, and the death of whole clumps has been very rare in the varieties grown, some twenty-five in number. This has been the case although the last two seasons have been, undoubtedly, very favourable for the attacks of the parasite, owing to the monsoon floods. This year there was a large number of single cane infections above the ground, but at harvest time it was found that these did not affect whole clumps and were clearly cases of new infections, probably through wounds, and there is no reason to anticipate any difficulty in keeping the new crop healthy. We have succeeded up to date in preventing the epidemic form of the disease, which results in the loss of whole clumps, while being unable to check the cases of new infection of individual canes. The disease appears to be under such control that in good seasons we may expect little or none and even in bad seasons, such as last year, we should not have any general destruction of the crop.

DESCRIPTION OF THE PLATES.

Plate. XI.—Appearance of sugarcane attacked by red rot. Fig. *a*.—A cane split open to show the reddening of the pith. Fig. *b*.—External view of a cane showing the black spore beds of the fungus at the joint, and also in longitudinal hollow below the joint.

Plate. XII.—Photograph of a plot planted with reddened and unreddened sets of *yerra* cane in alternate rows. Three months after planting.

Plate. XIII.—Photograph of a rattooned plot of diseased *yerra* cane, nine months after rattooning. The whole of the variety has been destroyed by red rot.

TABLE SHOWING THE CONSTITUTION OF THE IMPERIAL AND PROVINCIAL DEPARTMENTS OF AGRICULTURE IN INDIA.

Province.	Staff.	Agricultural Stations.	Educational Institutions.
	IMPERIAL DEPARTMENT OF AGRICULTURE.		
Imperial ...	1. Inspector-General of Agriculture— J. Mollison, M.R.A.C. (Cirencester). 2. Assistant Inspector-General of Agriculture— T. F. Main, B.Sc. (Edin.). 3. Director of Agricultural Research Institute and Principal of the Agricultural College, Pusa— B. Coventry (Beaumont College), (on leave); J. W. Leather, Ph.D., F.I.C., F.C.S. (offg. in addition to his own duties). 4. Imperial Agricultural Chemist— J. W. Leather, Ph.D., F.I.C., F.C.S. 5. Imperial Mycologist— E. J. Butler, M.B. (Dublin), F.L.S.; (Queen's College, Cork; University of Freiburg and Kew). 6. Imperial Entomologist— H. M. Lefroy, M.A. (Cantab.), F.E.S., F.Z.S. 7. Second Imperial Entomologist— F. M. Howlett, B.A. 8. Imperial Bacteriologist— C. Bergtheil (University College, London, Nüremberg and Agricultural College, Wye), on deputation under Bengal Government. 9. Imperial Agriculturist— E. Shearer, M.A., B.Sc. (Edin.) 10. Imperial Economic Botanist— A. Howard, M.A. (Cantab.), A.R.C.S. (Lond.), F.C.S., F.L.S., Diploma in Agriculture, Cambridge University, and Royal Agricultural Society of England.	1. Agricultural Research Institute, Pusa, Bengal. (General Experiment Station).	1. Agricultural College, Pusa, Bengal.

Province.	Staff.	Agricultural Stations.	Educational Institutions.
	IMPERIAL DEPARTMENT OF AGRICULTURE.—(*Contd.*)		
Imperial	11. Cotton Expert— (Vacant). 12. Supernumerary Agriculturist— A. G. Birt, B.Sc. (Durham). 13. Supernumerary Agriculturist— W. Roberts, B.Sc., (Bangor). 14. Supernumerary Agriculturist— G. H. Garrad, N.D.A., P.A.S.I. 15. Supernumerary Chemist— H. E. Annett, B.Sc. 16. Supernumerary Entomologist— C. W. Mason (South Eastern Agricultural College, Wye). 17. Supernumerary Botanist— R. J. D. Graham, M.A., B.Sc. 18. Supernumerary Mycologist— (Vacant).		
	PROVINCIAL DEPARTMENTS OF AGRICULTURE.		
Bombay	1. Director— P. J. Mead, I.C.S. 2. Deputy Director— F. Fletcher, M.A. (Cantab.), B.Sc. (Lond.), Diploma in Agriculture, Cambridge University, &c. 3. Second Deputy Director— (Vacant). 4. Assistant to the Deputy Director— G. S. Henderson, N.D.A., N.D.D. 5. Economic Botanist— G. A. Gammie, F.L.S. 6. Professor of Agriculture and in charge of Kirkee, Manjri, Lanowli and Poona Agricultural College Stations— J. B. Knight, M.Sc., (Massachusetts College) 7. Agricultural Chemist— A. A. Meggitt, B.Sc. (Lond.). 8. Divisional Inspector, Sind— Sidh Bisal Malhi, M.R.A.C. 9. Divisional Inspector, Deccan— G. K. Kelkar, L. Ag. (Bombay).	1. Kirkee, Poona, Deccan. (General Experiment Station and Dairy Farm). 2. Manjri, Poona, Deccan. (General Experiment Station, principally Sugarcane and Sewage Station). 3. Poona Agricultural College Station, (College Instruction Farm). 4. Lanowli, Deccan (Rice Experiment Station). 5. Surat, Guzerat. (General Experiment Station, principally cotton). 6. Nadiad, Guzerat. (General Experiment Station, principally millets and tobacco). 7. Dharwar, Karnatak. (General Experiment Station, principally cotton and millets). 8. Dhulia, Deccan. (General Experiment Station, principally cotton). 9. Mirpurkhas, Sind. (Cotton and Irrigation Station). 10. Muvalia Tank Station, Panchmahals, (Irrigation Station). 11. Gokak Canal Station, Belgaum. (Irrigation Station).	1. Agricultural College, Poona.

Province.	Staff.	Agricultural Stations.	Educational Institutions.
	PROVINCIAL DEPARTMENTS OF AGRICULTURE.—(*Contd.*)		
Madras	1. Director— M. E. Couchman, I.C.S. 2. Deputy Director— R. W. B. C. Wood, B.A. (Cantab.), Diploma in Agriculture, Cambridge University. 3. Second Deputy Director of Agriculture— H. C. Sampson, B.SC. (Edin.), F.H.A.S., F.R.S.E. 4. Government Botanist— C. A. Barber, M.A. (Cantab.), F.L.S. (on leave). 5. Principal, Agricultural College— C. J. W. Shepperson, B.SC. (Lond.), Diploma in Agriculture, Cambridge University. 6. Agricultural Chemist— W. H. Harrison, M.SC. (Victoria University).	1. Coimbatore Central Research Institute and Experiment Station. 2. Samalkota, Godavari. (Sugarcane Station). 3. Koilpatti, Tinnevelly. (General Experiment Station). 4. Bellary. (General Experiment Station). 5. Hindupur, Anantpur. (Agave Fibre Station). 6. Taliparamba, Malabar. (Pepper Station). 7. Palur, South Arcot. (Groundnut and Sugarcane Station). 8. Hagari. (Irrigation Pumping Station). 9. Nandyal, Kurnool. (Cotton Station). 10. Attur. (Cotton under irrigation and Fodder crops).	1. Agricultural College, Coimbatore.
Bengal	1. Director— C. E. A. W. Oldham, I.C.S. 2. Deputy Director— F. Smith, B.SC. (Edin.), F.H.A.S. 3. Principal of the Agricultural College— H. H. Corbin, B.SC. (Lond.), B.SC. (Edin.). 4. Agricultural Chemist—(Vacant). 5. Economic Botanist—(Vacant).	1. Bhagalpur Central Research Institute and Experiment Station. 2. Burdwan. (General Experiment Station). 3. Dumraon. (General Experiment Station). 4. Sibpur, Calcutta. (General Experiment Station, also demonstration for Agricultural College). 5. Siripur, Hathwa. (General Experiment Station and Cattle Farm). 6. Cuttack. (General Experiment Station, principally irrigation experiments). 7. Bankipur. (General Experiment Station). 8. Chaibassa. (Tasar Silk Farm).	1. Agricultural College, Bhagalpur.
United Province of Agra and Oudh.	1. Director— W. H. Moreland, B.A., C.I.E., I.C.S. 2. Deputy Director— J. M. Hayman, D.V.S. (McGill University, Diplomist of Guelph Agricultural College and Cambridge University). 3. Second Deputy Director—(Vacant). 4. Assistant Director— Khan Bahadur Saiyid Muhammad Hadi, M.R.A.C., M.R.A.S.	1. Cawnpore Central Research Institute and Experiment Station. 2. Orai, Jalaun. (General Experiment Station). 3. Aligarh. (Cotton Station). 4. Partabgarh. (Rice and Sugarcane Station). 5. Gursikran. (Station for reclamation of saline tracts). 6. Juhi. (Station for reclamation of saline tracts). 7. Abbaspur. (Station for reclamation of saline tracts).	1. Agricultural College, Cawnpore.

Province.	Staff.	Agricultural Stations.	Educational Institutions.
	PROVINCIAL DEPARTMENTS OF AGRICULTURE.—(*Contd.*)		
United Province of Agra and Oudh.	5. Economic Botanist— H. M. Leake, M.A. (Cantab.), F.L.S. (Christ's College, Cambridge). 6. Principal of the Agricultural College— A. W. Fremantle. 7. Agricultural Chemist— G. Clarke, F.I.C.		
Punjab ...	1. Director— W. C. Renouf, I.C.S. 2. Deputy Director— S. Milligan, M.A., B.Sc. (Edin.). 3. Principal of the Agricultural College— A. C. Dobbs, B.A. (Cantab.), Diploma in Agriculture, Cambridge University. 4. Agricultural Chemist— J. H. Barnes, B.Sc. (Birm.), A.I.C., F.C.S., R.I.P.H. 5. Economic Botanist— (Vacant).	1. Lyallpur Central Research Institute and General Experiment Station. 2. Sargodha Farm, Jhelum Colony. (Seed production).	1. Agricultural College, Lyallpur.
Central Provinces	1. Director— F. G. Sly, I.C.S. 2. Deputy Director— D. Clouston, M.A., B.Sc. (Edin.). 3. Second Deputy Director— (Vacant). 4. Assistant Director— Rai Bahadur R. S. Joshi, L.AG. (Bombay). 5. Principal of the Agricultural College— G. Evans, B.A. (Cantab.). 6. Agricultural Chemist— F. J. Plymen, A.C.G.I. (Lond.). 7. Economic Botanist— (Vacant).	1. Nagpur Central Research Institute & Experiment Station. (Principally cotton; Sewage Farm and Cattle-breeding Farm.) 2. Hoshangabad. (General Experiment Station, principally wheat and Cattle-breeding Farm.) 3. Raipur. (General Experiment Station, principally rice). 4. Akola, Berar. (General Experiment Station, principally cotton).	1. Agricultural College, Nagpur.
Eastern Bengal & Assam.	1. Director— S. G. Hart, I.C.S. 2. Assistant Director— B. C. Basu, Rai Bahadur, M.R.A.C., M.R.A.S. (England). 3. Second Assistant Director— (Vacant). 4. Fibre Expert— R. S. Finlow, B.Sc. (Bangor), F.C.S. 5. Economic Botanist— (Vacant). 6. Agricultural Chemist— (Vacant).	1. Dacca Central Research Institute and General Experiment Station. 2. Rajshahi. (General Experiment Station). 3. Rangpur. (Experiment Station, principally Jute and Tobacco). 4. Jorhat. (Sugarcane Station). 5. Shillong (General Experiment Station, principally temperate fruits and vegetables and sericulture). 6. Wahjain. (Experiment Station for tropical fruits and plants).	

PROVINCIAL DEPARTMENTS OF AGRICULTURE.—(*Concld.*)

Province.	Staff.	Agricultural Stations.	Educational Institutions.
Burma ...	1. Director— J. MacKenna, I.C.S. 2. Deputy Director— A. McKerral, M.A., B.Sc. 3. Principal, Agricultural College— E. Thompstone. 4. Agricultural Chemist— F. J. Warth, M.Sc. (Birm.). 5. Economic Botanist— (Vacant).	1. Mandalay. (General Experiment Station). 2. Hmawbi, Rangoon (General Experiment Station, principally rice.)	1. Agricultural College, Mandalay.
North-West Frontier Province.	1. Director— Revenue Commissioner (*Ex-officio*). 2. Deputy Director— (Vacant).	1. Peshawar. (General Experiment Station). 2. Swat River. (Canal Irrigation Station.)	

NOTES.

THE DEEPENING OF WATER RESERVOIRS IN CENTRAL INDIA.—In the programmes of works to be constructed during famines, frequent reference is made to operations under the head of deepening old water reservoirs, or tanks as they are commonly called. I doubt very much whether such outlay is always carried out to the best advantage. It is probably ten times cheaper to make a new tank than to conserve an equivalent volume of water by deepening the old one. For example: in projecting a new tank, the Engineer always examines the cost of storing the water per million cubic feet, and in favourable cases this varies from Rs. 300 to Rs. 1,000, according to the conditions of the site, a fairly average rate being Rs. 700. But if we measure by the same standard the result of deepening a tank, the figures are very startling. The carriage is bound to run into long leads, and the average cost per 1,000 cubic feet of silt will probably not be less than Rs. 7. Hence, expenditure on the extra storage obtained by removing one million cubic feet of silt amounts to Rs. 7,000, whereas the same volume can be conserved in a new tank for Rs. 700. The deepening of a tank is, moreover, likely to remove its water-tight lining, and I have come across cases where reservoirs are now useless, owing to the excavation of the bed down to the porous sub-soil.

Where a tank has obviously silted up, the cheapest remedy will be to raise the embankment. If this is carefully done, a very large accession to the storage volume is obtained, as the spread of water is bound to increase with every foot of height. The work, of course, should be carefully done, so that the raised embankment may be increased in strength as well as in height.

Where no professional advice is at hand, the following directions may be useful :—

(*a*) Clear the old embankment of trees and jungle growth, and take care that the roots are dug out ;

(*b*) Make the new embankment, six feet above flood level, ten feet broad on the top, with slopes of 2½ to 1 on the water side, and three to one on the rear ;

(*c*) The silt from the tank bed will afford the best material, but excavation should not take place nearer than 100 feet from the toe of the new slope. The shallower the excavation the better. First try whether a foot depth of digging will give enough spoil ; if not, take two feet, provided trial pits show that the porous stratum is not approached ;

(*d*) The walls of outlet sluices should be lengthened, to suit the slopes of the new embankment, for otherwise there will be weak points at such works ;

(*e*) Raising of the waste weir must be done very cautiously. For the first year, it will be safe to raise it only half the extra height, which has been added to the embankment. At the close of the monsoon, a temporary addition in the form of a clay bund may be placed on the silt. This will secure the volume which is escaping over the crest. Ultimately the sill could be raised to the level of the new full supply.—(H. MARSH.)

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SOUTH AFRICAN LOCUST FUNGUS.—A series of careful laboratory experiments has been conducted jointly by the Imperial Mycologist and Entomologist at the Pusa Agricultural Research Station, to test the efficacy of the South African fungus for the destruction of locusts in India. Pure cultures of the fungus (*Mucor exitiosus* Massee) were procured from South Africa, and were tested on the Bombay locust (*Acridium succinctum*, Linn), the black spotted grasshopper (*A. æruginosum*, Burm.), the North-West migratory locust (*A. peregrinum* Oliv.), and the rice grasshopper (*Hieroglyphus furcifer*, Serv). The experiments showed that the fungus does not appear to be capable of making a good growth on any of these insects, and that the method is too

uncertain to be of any assistance in the field in dealing with these insects. The detailed results will shortly be published in a Bulletin of the Department of Agriculture.—(F. G. SLY.)

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CALCIUM NITRATE AND NITRIC ACID.—It is only eight years since Sir William Crookes ventured, in his presidential address to the British Association, to point out the probable insufficiency of the world's wheat supply, and to urge the feasibility of bringing atmospheric nitrogen into combination as a means of indirectly relieving the pressure. There is, perhaps, no case in recent times where a prophecy of this important character has received so little credence, and which has neverthless been fulfilled in the immediate future. For not only has the manufacture of nitric acid by this means been realized, but another compound, namely, calcium cyanamide, also prepared electrolytically from atmospheric nitrogen, has been placed at our service to (*inter alia*) augment our fertilizer supply. In both cases the cost of the unit of nitrogen is already low enough to place these substances in competition with chili saltpetre and sulphate of ammonia. The relative prices, as stated by Professor Phillippe Guye (*Jour. Soc. Chem. Ind.*, XXV, p. 567), are as follows:—

Substance.	Price per Kilo of Nitrogen.
Calcium Cyanamide	Pence 14
Nitric Acid	„ 11
Calcium Nitrate	„ 12
Sodium Nitrate	„ 15
Ammonium Sulphate	„ 14

Calcium nitrate has only recently been placed on the market, and the experimental trials have not been numerous, but they confirm the anticipation that the substance will be fully as useful as chili saltpetre. Field experiments have proved the value of calcium cyanamide to be about equal to that of sulphate of ammonia. Pot cultures made at the Imperial Agricultural Research Institute, Pusa, with both these compounds have supported these views. It is proposed to utilize a part of the electric energy at the Kashmir installation for the maufacture of calcium

nitrate, and if this were carried into effect, the Indian monsoon would not only provide water for the canal systems, but would also indirectly place a supply of fertilizer at the disposal of crops.—(J. W. LEATHER.)

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A PEST OF STORED WHEAT SEED.—Several samples of wheat seed stored in bags at Pusa during the last monsoon were found at sowing time in October, to have been destroyed by an insect pest so far as germination was concerned, although from a milling point of view the damage was only slight. The injury consisted in the entire removal of the "germ" (embryo) by a small white grub leaving the rest of the wheat-grain intact. This interesting pest is said to occur frequently in Behar, where the remedy adopted by the cultivators is to spread the grain thinly in the sun when the worms are driven away.—(A. HOWARD.)

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WEEDS IN PUNJAB WHEAT FIELDS.—In the previous number of this Journal (Vol. I, p. 403), the possibility of the great value of *Senji* (*Melilotus indica* and *Melilotus alba*) in the wheat fields of the Punjab was discussed. During a subsequent visit to this Province, Mr. Milligan drew my attention to the fact that in the Eastern Punjab it is customary for the cultivators to sow *Senji* seed among the cotton just before picking time, so as to raise a rabi forage crop. It is very probable that by this means not only is a plentiful supply of fodder obtained, but also the soil is considerably enriched with nitrogenous manure.—(A. HOWARD.)

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ATROPA BELLADONNA.—This plant, commonly known as the Deadly Nightshade, owes its importance to an alkaloid which is distributed through the plant. There is a constant demand for the drug, which is at present met by importation. A market for a limited supply of root is thus available, if it is found possible to cultivate the plant in India. After a trial extending over a period of several years at Mussoorie, cultivation was discontinued in 1888, and the attempt is described as a failure.

Its cultivation has again been revived during the past year in the Kumaon Hills. Though it is as yet too early to speak with confidence, the results so far obtained are distinctly encouraging. The plant is richest in the active principle when about four years old, when the percentage in the dry root may be as high as 1. In the commercial root there is usually about 0·5 per cent. of the active principle. Reports on the roots in question, which are of a single year's growth, indicate a percentage of over 0·7.—(H. M. LEAKE.)

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CHRYSALIS OIL.—The oil of silkworm chrysalides has been examined by Dr. Lewkowitsch, who found that the smell resembles fish oil, and the colour dark brown, which may be improved by clarification with Fuller's earth. The chrysalides yielded 27·32 per cent. of the oil, which is considered suitable for low quality soap. The physical constants are given by the author (*vide* Zeits. untersuch. Nahar. Germs., 1906-12-659 ; also the Analyst. 1907, 53.)—(J. W. LEATHER.)

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TEOSINTE.—This fodder plant has been tested for the past twenty years in different parts of India. It is a native of Guatemala, the botanical name being *Euchlæna mexicana*, Schrad. synonymous with *Reana luxurians*. The results are generally disappointing. In the Bombay Presidency it was found not to be so good as the sorghums (Juar) usually cultivated : it takes longer to mature, is an exhausting crop, and cannot withstand drought, whilst the stalks were coarse and woody. In Madras, the trials showed that it requires good soil with liberal treatment and demands plenty of rain or frequent irrigation : the fodder was of poor quality and affected the taste of milk when fed to milch cattle. The results were somewhat more favourable in Bengal, where sorghums do not thrive in the heavy rainfall. It is an annual and must be sown at the commencement of the rains ; owing to its great tillering power, the plants should be 4 to 6 feet apart in good soil. It grows into a tall plant,

somewhat resembling maize in appearance, and gives about three cuttings with a heavy yield of green fodder. Bengal cultivators might try it as a fodder crop in tracts where the rainfall is too heavy for sorghum.—(F. G. Sly.)

***

The Fumigation of American Cotton Seed.—A new departure has been made in India by the issue of Notification No. 5103, dated the 3rd July, 1906, whereby Government has prohibited the bringing by sea or by land into British India of American or West Indian Cotton seed except such as has been fumigated to the satisfaction of the Customs Collector. This action was taken at the instance of the Bombay Chamber of Commerce, in order to protect India from the introduction of the Mexican cotton boll weevil, which has caused such enormous losses in the Southern States of America. The damage caused by this pest in 1904 was estimated by the United States Department of Agriculture at 450,000 bales of cotton, valued at 22 million dollars. It also occurs in Mexico, Guatemala and Cuba. It is known to live for long periods without food as a weevil, and is thus carried with cotton seed from place to place. The danger of introducing this insect into India in consignments of imported seed was, therefore, very considerable. Fumigation of the seed with carbon bisulphide effectually destroys the insect without damage to the seed, if it is properly carried out. This is the first case in which India has taken any steps to protect herself against a foreign insect pest. In many countries complete legislative measures have been passed to prevent the introduction of foreign insect pests and fungus diseases, and the time may shortly come when India will require to protect herself by similar means.—(F. G. Sly.)

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Papain or Vegetable Pepsin.—The Papaw (*Carica papaya*) is grown as a fruit tree in gardens throughout India, its ripe fruit being much appreciated. Of recent years a small trade has sprung up in some countries in the preparation from this fruit of a dry powder called 'papain.' It is well known throughout India

that the juice of both the fruit and leaves has a digestive action upon meat, the toughest meat being quickly made soft and tender, but no attempts appear to have been made to manufacture vegetable pepsin. It is doubtful whether this product would find a ready market in India, but there is a moderate demand for it in Europe, part of which might be met by manufacture in those parts of India where the local conditions are most favourable. An account of this product is given in Agricultural Ledger No. 31 of 1896, where the following method of manufacture is recommended :—" The best method to prepare papain is to collect the juice of the unripe fruit, mix the juice with twice its own volume of rectified spirit, let the mixture stand for a few hours, and then filter off the insoluble matter, and dry it at the ordinary temperature of the atmosphere. After being powdered it should be kept in well stoppered bottles ready for use." A more detailed account is given in Vol. I, No. 1, of the Agricultural News of Barbadoes.—(F. G. SLY.)

LITERATURE.

DATE VARIETIES AND DATE CULTURE IN TUNIS. T. H. KEARNEY. BULLETIN NO. 92, BUREAU OF PLANT INDUSTRY. U. S. DEPARTMENT OF AGRICULTURE, 1906.

THE publication of this Bulletin is of interest in India at the present time, in view of the attention that is being paid to the cultivation and improvement of the date palm in the Bombay Presidency and elsewhere. The author deals in a very able manner with the numerous varieties of Tunisian dates and with date culture generally in that region. The number of distinct varieties appears to be very large, and these the author classifies according to the character of the fruit. The chapters concerned with irrigation, drainage and alkali spots, will be of general interest to Indian readers as well as the description of the methods pursued in Tunis in ripening and harvesting the dates. Some of the varieties are said to be alkali-resistant. It appears from the author's observations and those of other observers referred to that the fruiting of male date palms is a well-known phenomenon.—(A. HOWARD.)

NOTICE.

THESE Memoirs, dealing with scientific subjects relating to Agriculture, will appear from time to time as material is available. They will be published in separate series, such as Chemistry, Botany, Entomology and the like. All contributions should be sent to the Editor, the Inspector-General of Agriculture, Nagpur, Central Provinces, India. Contributors will be given, free of charge, fifty copies of their contributions.

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VOL. II, PART III. QUARTERLY. *JULY*, 1907.

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CONTENTS.

THE OUDH SEED-DEPÔTS.

By W. H. MORELAND, B.A., LL.B., I.C.S., C.I.E.,

Director of Agriculture, U.P.

Many if not most of the cultivators in the southern districts of Oudh are unable to carry an adequate stock of seed from harvest until the following seed-time. There is no lack of appreciation of the benefits to be derived from choosing seed from the best of the produce, and the practice is followed, as far as possible, in the case of the crops which cost little to seed an acre; but with crops, such as wheat, where the cost of seed is considerable, the people have not the financial resources that would enable them to hold their stock. In practice they hand over their whole crop of wheat to the grain-dealer to be credited to their account, and at seed-time they go to him for the loan of the necessary seed.

This part of the country produces in a favourable year more wheat than it consumes, as the bulk of the inhabitants have to be content with coarser food-grains. The grain-dealer naturally sells the best of the wheat that comes into his hands, and issues the balance for seed, so that a process of deterioration in the quality of the seed is steadily at work. It is probably due mainly to this fact that the wheat ordinarily grown in South Oudh gives a poor yield of inferior grain.

The question of providing facilities for the supply of sound seed in such tracts was raised by the Board of Revenue in 1898. Some of the larger landholders professed interest in the matter and offered subscriptions towards the capital required, as well as their assistance in distributing seed to the cultivators and in collecting their payments at harvest-time; an advance

was obtained from Government to supplement the landholders' subscriptions; and an experimental depôt was established to test the question whether good seed could be profitably distributed as a commercial operation. At the outset, it was hoped that if this question could be answered in the affirmative, the larger estates would follow the example set them and would organize the seed-supply of their cultivators.

The landholders soon lost interest in the operation, or perhaps it would be fairer to say that their interest, never very strong, proved insufficient to cope with the objections of their subordinates to the extra labour involved in distribution and collection. But this first phase of the undertaking lasted long enough to show that, whatever the landholders might think, the cultivators were keenly alive to the advantages of a system by which they could be sure of sound seed on fair credit terms. At the same time the Department was getting popular with the cultivators, so that when the landholders' interest waned, it was decided not to suspend operations but to deal direct with individual cultivators for the time being in the hope of gradually developing a system from which Government could eventually withdraw.

Dealing with individual cultivators had numerous drawbacks. There were too many petty accounts to keep; collection became very laborious, and the cultivators had to be introduced by the subordinates of the Land Records Department. This last necessity was objectionable both as diverting the staff from their duties and as tending to a system of fees for introduction. The first step in organization was to encourage cultivators to form groups which would take over substantial quantities of seed and be jointly responsible for the return of the produce. By last year sufficient experience had been gained of these groups to justify their recognition as the normal customers of the depôt, and consequently a differentiation of interest rates has been made in their favour which will probably eliminate the individual customer.

The next step forward, the conversion of these groups into co-operative societies, will be the work of the Registrar.

Recent high prices have made it inadvisable to press this development forward, and only a few societies have been actually formed; but there is reason to think that many of the groups are ready, or will shortly be ready, to register themselves as societies, purchase a stock of seed with capital obtained through the Registrar at co-operative rates, and carry their stock from season to season. The chief anxiety of the groups appears at the present time to be the risk of loss in storage, by theft, fire, insects, etc. This question has still to be worked out with the people, but as a temporary measure I have offered to store in the Government depôts the stock of the pioneer societies in return for a charge per maund calculated to cover storage-charges and insurance.

Should these societies develop in the way that is hoped, the Department will have nothing further to do with the supply of seed for their members, except to assist them from time to time in adding to their stock, or in taking up a new variety. The assistance will be confined to purchasing for them the best seed available at the cheapest rate, or advising them where and how to purchase. It will not be financial.

The original intention was to offer the people chosen seed of the local strains, and this course is still followed in the case of some kinds of grain where the local supply is fairly good. But in the case of wheat, which forms the bulk of the distribution, a change of policy was necessitated partly by the fact that it was impossible to get enough good wheat of the local strains, and partly because the people were tired of their own and asked for a different strain. The soft white wheat, known as Muzaffarnagar, had been tried in the locality with sufficient success to justify its offer, and it has been the principal grain supplied; it has now become popular with the people as giving a considerably greater net return than the local strains. Oats have been introduced in one or two places where there was a demand for the crop, but the market is too limited for this crop to become very important; and a variety of fine rice which commands very high prices in the market, appears to be becoming popular.

The terms offered were 25 per cent. for the crop; that is to say, a cultivator who takes a maund of seed undertakes to repay 50 seers of its produce after harvest. If he prefers—as some do—to pay in cash, the cash rate is fixed beforehand at a slightly unfavourable figure from his point of view, as in order to maintain the stock it is desirable to get back as much grain as possible in kind. This rate of interest was fixed as the commonest prevailing rate in the locality, as it was desired not to appear to enter on the enterprise of reducing interest. As a matter of fact, the charge to the people has in some cases been reduced, because some dealers adjust their rates by the difference between prices at seed-time and at harvest, but reduction was not part of the scheme. At present a rebate of one-fifth the interest is being offered to groups provided they pay in their produce punctually in one lot; thus a group which has taken 10 maunds of seed need pay only 12 maunds instead of $12\frac{1}{2}$ maunds under the previous rule. This reduction is justified by the greater security, the saving of labour in collection, and the reduction of account work. On the other hand, from next year the rate to individuals will be raised to $37\frac{1}{2}$ per cent. in furtherance of the policy of encouraging the formation of groups.

The working of the depôt may be described as follows:—

The representatives of a group are now known to the agricultural staff and need no introduction, but individuals have to be introduced. In either case the issue is made on application with the minimum of formalities, and there is nothing more to do till harvest time. It is here that difficulties occur in collection from individuals. We have hardly had a single case of fraudulent refusal to pay, but debtors expect to be reminded, and this entails much work on the revenue-staff of the sub-division; work which will, I hope, be reduced to a minimum as the group-system develops. As each lot of seed is returned, it has to be examined for fitness for re-issue, and then cleaned and bagged under the supervision of the agricultural staff. At first a seed-separator was used for cleaning, but hand-sieves have been found more suitable. The cleaned seed fit for re-issue is then stored

and the inferior seed and cleanings sold off for cash at a period when the market is favourable.

As regards storage, Khan Bahadur Muhammad Hadi, who has supervised operations since the start, has developed and adapted the indigenous methods on lines which he describes as follows :—

"Seed-grains may be stored either in pits (under ground) or in chambers (over ground) in a building (two-storied preferable) having but one entrance to the north or south. The most suitable shape for the pits or chambers is oblong, the dimensions, of course, depending on the amount of grain which has to be stored. The pits or chambers should be perfectly dry to begin with. The walls and the floor thereof should then be well coated with coal tar and allowed to dry. Before storing the seed, about half an ounce of sulphur should be burnt in each chamber and the door of the building should be closed while the sulphur is burning. Leaves of '*Mahua*' (Bassia latifolia) and '*Nim*' (Melia indica) should be collected beforehand and dried. A layer of *Mahua* leaves about 6 inches thick should first be spread on the floor and over this a thinner layer of *Nim* leaves. On the latter should be spread a six-inch layer of *bhusa* (the common wheat or barley straw). The grain should be *thoroughly* dried in the sun before storage and should be packed in bags in the *hot sun of June* (which is the best time for storing *rabi* seeds). Before the bags are stitched after being filled, two or three one-inch bits of naphthalene should be put in each bag. The bags should now be removed from the sun to the chamber and placed on the layers mentioned above. The upper surface of the bags should then be covered with a two-inch layer of *bhusa*, and on this layer should be placed a fresh layer of bags and so on till the chamber is full. A space of about one foot should be left all round the chamber inside to be closely filled with *bhusa* as each layer of bags is placed in it. The chamber should in this way be filled up to the top when a thick layer of *bhusa* should be spread and covered over with a piece of *tat* or some sort of matting. In the rainy season the bags should be examined once

a fortnight with an instrument well known to grain-dealers. It is called *parkhi* and is similar to the instrument used in Europe for examining cheese. Should any traces of an attack of weevils be found in any bag, the latter should be removed from the granary at once. The use of naphthalene minimizes injuries from the common granary pests but renders the seed unfit for eating purposes owing to the disagreeable odour which it imparts to the grain.

Kharif Seeds.—Among the kharif seeds, rice does not require all this careful treatment, but *Urd*, *Mung* and *Juar* do.

Maize is specially liable to attack of weevils, and it should be *very thoroughly* dried before storage under the above method. The best way for keeping maize seed is to suspend the ripe cobs (they should be *dead* ripe) in a kitchen or some other room where smoke gets in regularly every day."

It may be added to the foregoing account that losses from weevils have on the whole been trifling.

It is found that in ordinary seasons the stock of grain increases as rejections and cleanings do not consume the whole of the interest received: but after a bad season it may become necessary to renew a considerable part of the stock by fresh imports, when charges for freight reduce the accumulated profit, while as prices are usually high when fresh purchases have to be made, the writing down of the new stock to normal values affects the balance-sheet very materially. The financial arrangements will be understood from the following balance-sheet made up on 31st August 1906: the depôt has a personal ledger account with the treasury:—

Liabilities.	Rs.	A.	P.	*Assets.*	Rs.	A.	P.
Due to Government ...	14,000	0	0	Gram, bags & straw in stock or advanced ...	13,679	9	9
Reserve	2,000	0	0	Outstandings ...	2,536	1	11
Subscriptions ...	875	0	0	Dead stock ...	41	15	0
Profit	1,478	15	3	Cash	2,096	4	7
	18,353	15	3		18,353	15	3

Taking each item in turn, the sum *due to Government* represents the bulk of the working capital : it is technically an advance under Article 137 (*a*) of the Civil Account Code. The *reserve* represents a contribution made by the Government of India some years ago to enable the stock to be extended at a period of famine-prices ; but for this grant, the depôt, as a commercial institution, would have been bound to limit its operations till prices fell, while with the aid of the grant it was possible to purchase more seed and do substantial good. For accounts purposes the amount of the grant is still shown as a reserve fund, and part of it will probably disappear from the next balance-sheet, as the stock of seed has again been increased at a time of high prices. The *subscriptions* represent the original contributions of landholders, and the *profit* is the balancing item.

On the assets side, the *seed-grain* is valued at normal prices, the other *stock* at a low figure. The *outstandings* show the normal value of the grain due to the depôt at that date, while the *cash* represents the value of seed sold for cash as unfit for stock, etc. This has almost all been spent in adding to the stock of wheat. Contingent expenditure and wages are paid from the cash-balance.

It should be added that two district boards have established seed depôts on similar lines : they are worked by the staff of the department but financed by the district boards.

THE THIRD ANNUAL MEETING OF THE BOARD OF AGRICULTURE.

By E. J. BUTLER, M.B., F.L.S.,

Secretary to the Board.

THE expansion of Agricultural Departments in India, noted in the account of the second meeting of the Board of Agriculture (Agricultural Journal of India, Volume I, 1906, page 143), was still more evident at the third meeting which opened at Cawnpore on February the 18th, 1907, under the presidency of Mr. F. G. Sly, I.C.S., Officiating Inspector-General of Agriculture in India. Forty-six members attended as against thirty-five in the preceding year, the increase being more than accounted for by the presence of thirteen new officers appointed to the staffs of the Imperial and Provincial Departments of Agriculture during the year. Besides a very full muster of these Departments, the Board included the Inspector-General of the Civil Veterinary Department, the Director of the Botanical Survey, the Agricultural Chemist to the Government of Mysore, the Scientific Officer to the Indian Tea Association and the Directors of Agriculture of Baroda and Kashmir. The Board had also the pleasure of welcoming as visitors Sir Edward Buck, K.C.S.I., and Major E. H. Atkinson, R.E., Principal, Thomason College, Rurki, both of whom made valuable contributions to its proceedings.

The two previous meetings were held at Pusa. The new departure, of meeting alternately at Pusa and at one or other of the Provincial Departments' head-quarters, proposed by the Board in 1906, has met with general approval. As one of the main objects of the Board is to give to agricultural officers throughout India an opportunity of meeting together to learn something of

each other's work and to discuss their problems from the different stand-points induced by local conditions, it is felt widely that the advantage which will accrue from seeing the actual working of the departments in different provinces fully justifies the change.

The annual meeting of the Board of Agriculture is an occasion on which a review can be made of the progress of State-aided improvement in Indian agriculture during the preceding year. Though this is not an admitted function of the Board, which in its official discussions applies itself rather to plans for the future, it is still an inherent necessity of any such meeting, since it is impossible to discuss the future, without reference to the past. The opportunity has, indeed, been taken by the President at the last two meetings to refer briefly to the results during the year of the action taken on the recommendations made by the preceding Board. The programmes of work submitted by the Departments of Agriculture also contain frequent references to current work and to new lines taken up during the year. It is, therefore, possible from this point of view to gain a general idea of the activities in agricultural matters of the State departments concerned.

In attempting to give a brief review of the salient features of the year's work, as they can be gleaned from the Proceedings of the Board of 1907,* it is necessary first to make some reference to the organization of the Agricultural Departments in India, and the expansion of their staffs which has taken place in 1906-07. A very complete account of these Departments, with detailed lists of their staffs as they stood at the beginning of 1906, will be found in an article in this Journal on "Departments of Agriculture in India" by Mr. F. G. Sly (Agricultural Journal of India, Volume I, 1906, page 1). The Imperial Department as it stood in the beginning of 1906 has undergone

* Proceedings of the Board of Agriculture in India, held at Cawnpore on the 18th February 1907, and following days. Calcutta, Office of the Superintendent of Government Printing, India. Price, Rupee 1, annas 2; or 1*s.* 6*d.*

no considerable change. Five new officers were, however, posted to Pusa in the period under review, to receive a course of training intended ultimately to prepare them for responsible posts in the Provinces. The addition of these officers—known as Supernumeraries—to the different branches of Agricultural Science represented at Pusa, has become an important feature in the organization of the Pusa Institute, and every section has been, or will shortly be, strengthened by one or more junior officers. As vacancies arise, these will be posted to the charge of sections in the provinces.

The Provincial Departments have made a decided advance towards the organization outlined in Mr. Sly's article already referred to. A separate Department of Agriculture, distinct from the Land Records Department with which agriculture was previously amalgamated, has come into being in nearly all the provinces, and in each case is in charge of a special officer of the Indian Civil Service as Director of Agriculture. Each Department has obtained, or will very shortly obtain, a nucleus staff consisting, in most cases, of a Principal of the provincial agricultural college, a chemist, a botanist and one or more expert agriculturists. Entomologists and mycologists will not at present be appointed to any province, the whole of the work of these sections being for the present centred at Pusa, with the assistance of native staffs in the Provincial Departments.

The recruitment of the very large native establishments required has naturally been much hampered by lack of suitable trained candidates, but this is inevitable pending the completion of the agricultural colleges; the supply from them of well-trained men will eventually remove this difficulty. Besides the European staff of specialists mentioned, native assistants and subordinates are, therefore, being largely employed and will be graded into a regular service on rate of pay and prospects which will attract highly educated men who have been brought up among agricultural surroundings.

So much for the personnel. The material equipment has made an equally decided advance. The Agricultural Research

Institute at Pusa is approaching completion and it is anticipated that its laboratories will be occupied in the current year. In each province the site for the central provincial college and research station has been selected, and in most cases, considerable progress has been made in erecting the necessary buildings and laying out the land. Most of the provinces have been surveyed with a view to select suitable localities in which to found experimental farms, and the number of such farms in existence has largely increased. When completed, there will thus be besides the Imperial Research Institute at Pusa, eight provincial colleges and experiment stations, with full laboratory accommodation for scientific work, and a large number of experimental farms and demonstration plots in representative agricultural tracts throughout the country.

The degree of activity shown by the different departments naturally varies greatly in accordance with the staff available. In Burma, for instance, the Director was entirely without a scientific staff until nearly the end of the period under review. Several other provinces were but little better off. In Bombay, on the other hand, nearly the full staff was available. It is impossible to refer more than very briefly to a few of the directions in which the different departments have been active.

The work of the Agricultural Research Institute, Pusa, was outlined by a committee of the Board of 1906, who held that it should be directed, as far as possible, to solutions of the fundamental problems of tropical agriculture, the provincial departments undertaking more detailed or local work, of immediate application to local agriculture. Inevitable delay has occurred in inaugurating any large series of field experiments at Pusa, owing to the necessity of testing the soil of the different blocks. Uniform cropping for several seasons, so as to obtain a knowledge of their characters, has been the first requirement. When taken up in 1903, a large part of the present arable area was under jungle and all was in an unsatisfactory condition agriculturally. Hence, no field experiments proper have yet been commenced, and much time has been expended in mapping the farm into acre plots, the

yields of which have been separately weighed and recorded, so that a considerable amount of information as to the capabilities of the different fields has been acquired. Soil analyses of a very extensive nature have been made, and samples of all the blocks preserved for future comparison. It has, however, been possible to carry out a certain number of crop experiments in available portions of the farm, experiments in sugarcane cultivation, the testing of varieties, their period of maturing, behaviour to disease and so on, and the experimental cultivation of cotton and flax, being the chief of these. The ordinary work of laying out the farm has, of course, taken much time, but the necessary bunding, fencing, road-making, providing irrigation and so on, are now nearly completed, and it may be expected that permanent field experiments can very soon be commenced. The details of these are not, however, yet definitely settled, but it is safe to say that an important part of the experiments will be permanent series, something on the lines made famous by the work carried on at Rothamsted in England, but with special reference to sub-tropical practices and conditions.

In chemistry the work has included the determination of available plant food in soils. This has been carried out largely in the pot-culture house, a well-equipped structure which has been erected for work of this nature. The results obtained up to date will shortly be published. The amount of nitrogen compounds in rain-water and dew has been determined, in work extending over a year in each case. The published results show that the quantities, contrary to what has often been suggested, are no greater than those similarly found in England. The subject of soil drainage has also been taken up, with the aid of four drain gauges erected for the purpose. These are solid blocks of soil, cut out and underpinned without any disturbance, and they provide a means of collecting and examining the drainage water through different thicknesses of a measured area of surface. Other investigations of the quantity and movements of soil moisture have been carried on, and it is expected that some interesting data will be available for publication shortly. Similarly, an apparatus for determining the

quantity and character of soil gases has been perfected, with a view to obtaining information on this little known subject. Investigations have also been carried out on the conditions which lead to an accumulation of the cyanogenetic glucoside, which gives rise to prussic acid in certain plants, such as sorghum (*Andropogon Sorghum*) and linseed, (*Linum usitatissimum*) so often fatal to cattle, and on the value of the recently introduced artificial manures, calcium cyanamide and calcium nitrate.

In botany the chief work has been investigations in plant breeding and plant improvement. The determination of the varieties of Indian wheat has been taken up, a very large collection of the Indian wheats having been grown at Pusa and their characters studied, the almost invariable mixtures being separated into their component types. Similar work with barley and tobacco is also in progress.

A commencement has been made in wheat breeding work, a number of successful crosses having been obtained. The results which have attended this class of work in other countries hold out considerable promise for similar work in India, where little breeding has previously been attempted. The collection and investigation of certain fibre plants has also been commenced. The first step is to collect material for growing under uniform conditions, in order to determine whether the varieties of any particular fibre plant are true to type, and to isolate and examine the types. The value of these types will then be determined. Hibiscus cannabinus (*Patsan*) has been selected for immediate investigation. Other work includes a series of permanent experiments on the culture of Indian fruits, and the study of the varieties and cultivation of cassava, with particular reference to the amount of starch and prussic acid-producing glucoside present, the Agricultural Chemist collaborating in the latter investigation.

In entomology and mycology the work has naturally been of a somewhat different character. Since no provision for these sections has, at present, been made in the provincial departments, the acquirement of information regarding Indian insect and fungus pests of cultivated crops has necessarily occupied a large

proportion of the time of the sections concerned. The accumulation of collections and their identification, and the giving of advice to cultivators and others regarding their pests, form an important part of their work.

In entomology a staff of native assistants has been trained and posted to different provinces. These men are employed in field observations of the more serious crop pests and in urging on the cultivators the adoption of simple remedial measures. Slow but real progress in this direction is recorded, aided by the publication of a volume on "Indian Insect Pests," which may be expected to promote the spread of more common-sense views as to the origin and nature of insect epidemics. An attempt has been made to discover insecticides fatal to insects, but not, in the quantities used, to cattle or other stock. This has been carried out in collaboration with Mr. R. S. Finlow. The value of *trap* crops in preventing insect epidemics, the influence of climatic conditions on their prevalence, and the practicability of utilizing beneficial insects as a means of checking pests, were also enquired into at Pusa. Large reference collections are being accumulated and identified with the aid of specialists in Europe and America. The special investigations included an enquiry into the prevalence in India of biting flies which may act as carriers of disease. This is a subject which has reached great importance in medical and veterinary science recently. Little is known of the species which occur in India, and a comprehensive survey of them may prove of great value in the discovery of the causation of certain human and animal diseases. A severe epidemic of the cotton boll-worm has recently occurred in the Punjab and Sind. To combat this a large campaign was undertaken in the Punjab, the chief means adopted being the re-introduction of the natural enemy of the boll-worm, a parasite which, there is reason to believe, was killed out by the severe cold of the winter of 1905-06, the burning of stalks and refuse of the cotton plant in the fields, after the completion of the cotton picking season, and the planting of *trap* crops of *bhindа (Hibiscus esculentus)*. The result was a distinct improvement in the crop in 1906-07.

In mycology the training of assistants for posting to the provinces has been started in a similar manner to that mentioned above for the entomological assistants. Little progress may, however, be expected from any efforts at present to teach cultivators to understand their fungus pests, for a considerable amount of education is required before the nature and effects of these obscure and minute parasites can be grasped. Attempts have, therefore, been made to indicate directions in which Government may take action in stamping out epidemic diseases and also to find disease-resisting varieties of crops subject to specific diseases. As an instance of the former, a large campaign has been started in the Godavari Delta to stamp out a very serious palm disease which threatens the extinction of palmyra and cocoanut palms in that area. This work is being carried out by the Madras Department with the necessary expert advice and assistance from Pusa. It is hoped, however, that in this case, material co-operation may eventually be secured from the ryots. The attempts to obtain a race of pigeon pea resistant to the wilt disease of this crop are promising well at Poona. At Pusa investigations of some of the chief diseases of sugarcane have been carried on, and a simple and efficient method of checking "red rot," the most serious disease of this crop, has been discovered. Research work has occupied much time, as a natural preliminary to the introduction of remedial measures in a country in which the crop diseases are largely uninvestigated at present. The collection and identification of Indian fungi is also a necessary preliminary to future work.

The work which is being carried out by the provincial departments, as submitted to the Board, is so extensive and varied that only a brief reference to its main features is possible here.

Efforts towards the improvement of Indian cotton are receiving considerable attention. The attempt to acclimatize Egyptian cotton in Sind has attracted much notice, not only in India, but in the markets of the world. There is no need to refer

at length to this experiment, the details of which are probably familiar to most readers from the columns of the daily press. The success of its early stages is promising, but consideration must be given to overcome the habits and traditions of the cultivators, which deter them from the labour and care required in growing these cottons, and the ravages of the boll-worm, before any considerable supply can become available. Egyptian cotton is also being grown in the South Western Punjab. A classification of Indian cottons grown at Poona and an account of some of the tree cottons have been prepared by Professor Gammie, Economic Botanist, Bombay. In Bengal and elsewhere trials of these tree cottons have been carried out, without, as yet, any definite success. Several hybrid cottons have been produced in Bombay and the Central Provinces and are being tested. In the Punjab, fifteen hundred acres were sown with acclimatized American cotton in 1906, and a substantial increase is anticipated this year. In the United Provinces a medium stapled American cotton has been acclimatized and introduced on a small scale near Cawnpore. Cotton seed selection is in progress in most provinces, the superior seed being distributed to the ryots. In the Central Provinces three farms are devoted to this work.

Wheat experiments, particularly in the introduction of improved varieties, are in progress in the wheat-growing provinces. In the Punjab some of the varieties introduced at Lyallpur have found much favour. At Cawnpore and Orai wheat-breeding work is being carried on, search being made particularly for a rust resistant wheat for Bundelkhand. In Bombay similar work has been initiated. At Hoshangabad in the Central Provinces wheat is under special study, and in these Provinces demonstrations on the advantages of saltpetre as a manure for irrigated wheat are being given.

In sugarcane the farm at Samalkota has done much good work in introducing new varieties into the Godavari Delta. This farm is devoted chiefly to the study of this crop. At Manjri, near Poona, sugarcane is also the chief crop and the

work of the farm has exercised a wide influence on surrounding cultivation. In Assam attempts are being made to popularize sugarcane growing. The Agricultural Chemist to the Mysore Government has made an enquiry into the industry in that State, and indicated several directions in which improvement in manufacture can be carried out. The Hadi process of sugar making is being taken up by cane growers in the United Provinces.

The improved cultivation of paddy, introduction of new varieties and experiments in transplanting and manuring are being carried out at several farms in Bengal, at Raipur in the Central Provinces and at Rajshahi in Eastern Bengal. The efficiency of *rab* is being tested at Lonavla in Bombay.

Tobacco cultivation and curing are being studied at Nadiad in Bombay, Dindigal in Madras and Rangpur in Eastern Bengal. New varieties have been introduced into Cocanada and Koilpatti in Madras.

The improvement of potato cultivation in the Khasi hills is one of the chief aims of the Shillong farm where new varieties are introduced, spraying for disease demonstrated and manurial experiments tried. Disease resistant potatoes are being sought for at Dharwar in Bombay.

Special farms have been opened for the study of groundnut at Palur in Madras, pepper at Taliperamba in the same Presidency and Tasar silk at Chaibassa in Bengal. Groundnut is also being studied on some of the Bombay farms. At Kanara spice cultivation is especially under enquiry. The tropical Garden at Wahjain in Assam is devoted to spices, drugs and tropical fruits, while temperate vegetables and fruit are being acclimatized at Shillong. Rubber, fibres and a number of exotic and Indian economic plants are receiving attention at Ganeshkind Gardens in Bombay, where also there are experiments in fruit growing. A new economic garden for similar work has been opened at Bassein on the sea coast north of Bombay.

At most farms in all the provinces there are experiments in cultivation, manuring, seed-rate, introduction of varieties and

similar questions, with a large variety of crops, including most of the staple crops of the country.

Seed farms for the supply of good seed of cotton, wheat, jute and other crops have been opened in several provinces.

Of special enquiries mention should be made of the *reh* or alkali land investigations in Sind, the United Provinces, and the Punjab. Efforts at reclaiming alkali land by the application of gypsum, by drainage and by washing out the salts are in progress. In the United Provinces a survey has been made to locate sites where wells may profitably be constructed and a special well-boring staff entertained to conduct trial borings. In times of scarcity the assistance of Government for these minor irrigation works has been secured, according to a definite programme. A scheme for a similar survey has been prepared for the Punjab. Investigations of questions of soil nitrogen, determination of seepage in field irrigation channels, soil inoculation of leguminous crops and studies in insect and fungus pests are carried on at Cawnpore. Studies of root parasites, especially the sandal tree, and a survey of the wild peppers of the Presidency have been carried out by the Government Botanist, Madras. The co-operative system of seed distribution which has been devised in the United Provinces has been described at length in the present issue of this Journal.

Besides the general agricultural work of the departments, mentioned above, several important crops have been made the subject of investigation by special officers appointed for the purpose. These are indigo, tea, jute and other fibres. The Indigo research station of the Behar Indigo Planters' Association receives a subsidy from the Bengal Government and is under the charge of the Imperial Bacteriologist who has been lent from Pusa for the purpose. The nature of indigo fermentation has been investigated and several improvements in manufacture carried out. The station has also been concerned in the extension of the Natal plant, which has revived the indigo industry, moribund under the competition of artificial or synthetic indigo. Recently a series of dying tests has been carried out which indicates a marked superiority of the natural over the

synthetic product. A large number of other investigations connected with seed raising, improvement in germination of Natal seed, cultivation, trials of varieties and other questions have been carried out.

The scientific department of the Indian Tea Association is under the charge of a special officer appointed by the Association and maintains an experiment station at Heleeaka in Assam. It receives subsidies from the Governments of India, Bengal and Eastern Bengal and Assam. During the period under review investigations have been carried on on the fermentation of tea, the causes which influence "quality," the characters of the tea soils of North Eastern India, several insect and fungus pests of tea (including the mosquito blight, red slug caterpillar, blister blight and red rust) and questions of manuring and cultivation. The value of the work of this department has received wide recognition from the tea industry.

Attached to the Eastern Bengal and Assam department is a special Fibre expert, whose work has been chiefly connected with jute. A survey has been made, as a result of an extensive tour, of the districts in India which appear to offer promise of success in jute cultivation. The extension of the area under jute is one of the first needs of the industry at present, as an increased demand has led to fraudulent watering on an extensive scale and the supply of inferior grades of fibre to the market. Experiments were carried out to determine the quantity of moisture naturally taken up by jute fibre under different conditions, in order to provide a basis for legislation should it be needed. Retting experiments were also carried out. Field experiments on the best season for sowing and thickness of planting are in progress and trials of a number of other fibres, possible substitutes for jute, have been made. Selection experiments with jute, designed to improve both the quality and yield of fibre, have been commenced and will form an important part of future work.

The consideration of the programmes of different departments, from which the above abstract has been made, occupied the first two sittings of the Board. The remaining three days

were devoted to the discussion of several matters of general interest to all the departments.

The chief of these was the improvement of the Indian sugar-cane industry. The available statistics show that the consumption of sugar in India is increasing, while there is no corresponding growth in the area under cane in the country. It is everywhere recognized that, though India possesses canes, the quality of which is not surpassed in any country, still the yield of raw sugar per acre as a whole is lower than in any other sugar producing country. A scheme was prepared, after prolonged discussion, of the directions in which improvement can be attempted, and was adopted as a general guide to the departments of provinces in which the crop is of commercial importance. This scheme is contained in the published proceedings and need not be further referred to here.

Arising out of the grant of £10,000 made by the British Cotton Growing Association, the Government of India requested the advice of the Board regarding the best plan for assisting cultivators in disposing of small quantities of any new fine stapled cotton introduced into cultivation. The Board recommended that the direct intervention of Government should be restricted to the earlier stages of any such introduction. In these early stages it may be advisable for Government to purchase the produce. Later on, when the area commences to expand, the assistance of private firms acting independently or as Government agents may usefully be sought. With still larger areas Government auctions, such as those held in Sind to dispose of the newly introduced Egyptian cotton, are recommended.

The question of legislation for the control of artificial fertilizers, brought before the Board of 1906, was again considered; the Board decided from the evidence collected in the meantime that the time is not ripe for the introduction of such legislation, though it is desirable to maintain a special watch over the developments which may occur in the future in this direction.

Sir Edward Buck gave addresses on two important questions which led to interesting discussions. The first of these was the utilization of river silts in India. The quantity and nature of

these silts is under investigation by the Imperial Department of Agriculture and by the Geological Survey. Their agricultural value was testified to by a number of members present, and the discussion elicited many facts of general interest in this connection. The Board agreed that it is a grave error not to utilize fertilizing silt wherever it may profitably be used, and recommended that silt investigations should be continued and extended, and that the co-operation of the Irrigation Department should be sought in the enquiry. The second matter brought up by Sir Edward Buck, was the employment of Agricultural Engineers in India. He instanced a number of important enquiries in which the services of trained engineers could profitably be utilized. The work which has already been done in such directions as well boring, lifting well water by power, checking erosion and carrying out minor irrigation work, though on a small scale, was appreciatively referred to by several members. As a result of these indications Major Atkinson, R.E., Principal of the Thomason College, Rurki, explained to the Board the technical qualifications required for such posts and the training necessary for the subordinate staffs. The Board recommended the question to the earnest consideration of local departments.

Of veterinary matters the chief considered was the provision of fodder in times of famine. A number of suggestions were made in this connection, and the Board recommended them for the consideration of the local departments.

The above summary of the matters considered at the Board of Agriculture of 1907, gives some indication of the work of the different departments and special officers. If it is remarkable rather for the amount of experimental and research work projected than as a record of improvements actually accomplished, this is partly accounted for by the fact that the Board occupies itself, as already said, more with the future than the past. It is also, however, in a large measure due to the recent birth of systematic agricultural enquiry in India, and it cannot, I think, be denied that the infant departments show remarkable signs of vigour and that their future careers are full of promise.

LOCUSTS IN INDIA.

H. M. LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist, Pusa.

INDIA is the home of two locusts, which are periodically destructive to the crops and are familiar to agriculturists in the tracts through which they pass. These two species differ in habits and life-history and are checked by diverse methods. In order to facilitate their recognition, we reproduce coloured plates of these insects, and this short article is merely an amplification and explanation of the plates.

For many reasons it is important to be able to recognize a locust and make quite certain which one of the two kinds it is; knowing this, it is possible to predict what will happen whether damage is to be anticipated, whether locusts are likely to lay eggs, and whether any precautions are possible. There are great gaps in our knowledge of locusts which we hope to fill if readers of the Journal will report every flight of locusts they see. For this, it is absolutely necessary to be able to identify the locusts with perfect certainty, and we hope that this will be possible by means of the plates.

A locust is a grasshopper which multiplies excessively, forms swarms and migrates, passing over long distances and settling here and there to feed. There are authentic records of only two insects in India which behave like this, but there is no reason why any of our common grasshoppers should not do so. If therefore the reader finds a swarm of locusts, the individuals of which do not agree with those represented here, we hope he will post specimens to Pusa with a short report. There have been reports of a green locust in Orissa, of curious locusts in Madras, of flights

PLATE XIV

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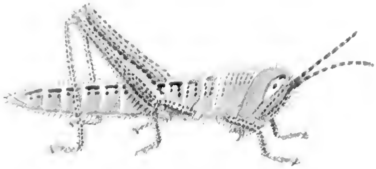

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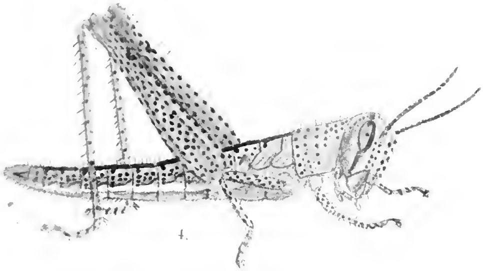
THE BOMBAY LOCUST.

PLATE XV.



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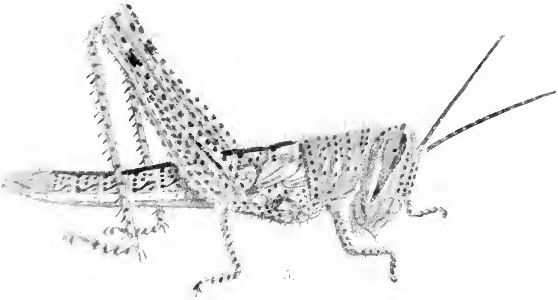

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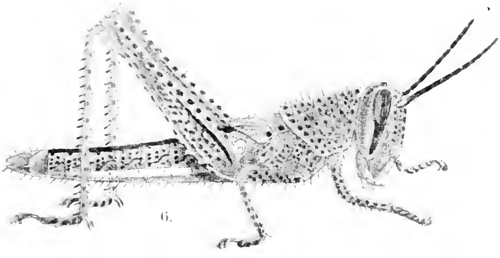

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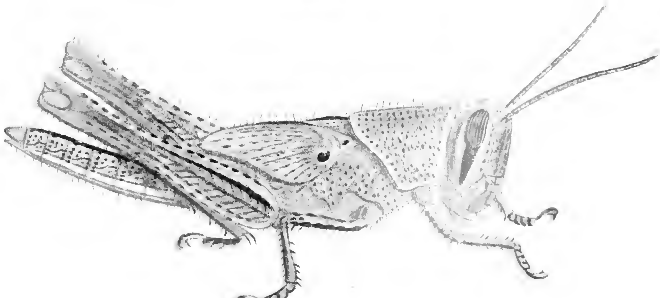


THE BOMBAY LOCUST.

Engraved and Printed
by The Calcutta Phototype C

of the Central Asian Locusts coming into India and so on, and it is desirable that these should be authenticated.

Plate XIX represents the North-West Locust.* This insect extends from Algeria through Northern Africa, into Cyprus, Arabia, Persia, through Baluchistan, into Sind, Kathiawar, Rajputana and the Punjab. From the last four areas it flies in vast swarms over Northern India, into the Western Himalayas, into the United Provinces, Behar, Bengal, and up the Assam Valley to the Eastern Himalayas. Calcutta is visited only occasionally, and is perhaps the Southern limit of its usual wanderings, (though swarms have been recorded from the Godavari Delta), while Assam, which is also only occasionally visited, forms its eastern limit.

In the flying stage this locust occurs in two colours; when it first acquires wings it is pink with a purplish tinge (Plate XIX, Fig. 20); in this stage it flies actively and for great distances; later, when it is about to reproduce. it becomes yellow (Plate XIX, Fig. 21) and, since the females are burdened with eggs, it now flies more slowly and for shorter distances.

When a swarm of yellow locusts is seen, egg-laying may be expected, but, before this occurs, they will settle and mate. A characteristic of this locust is that it lays its eggs in sandy places in fairly dry loose soil; large numbers lay their eggs together in one spot, and one may find as much as a maund of eggs laid in a few suitable spots included in an area of a few acres. A single egg cluster contains about 100 eggs, and weighs about 11 grains; a seer of eggs totals about a lakh, and a maund about 40 lakhs.

Speaking generally, there are in India two broods of this insect yearly; eggs are laid, say, in February—March; they hatch in about six—seven weeks depending on temperature; the hoppers live for about six weeks and undergo six or seven moults; at the last moult the winged insect appears, and after some time flies away. It then lives for about three months, becoming yellow

* This is known to science as *Acridium* (Schistocerca) *peregrinum* Oliv.

after about two months, as a rule; having mated and laid eggs, it dies.

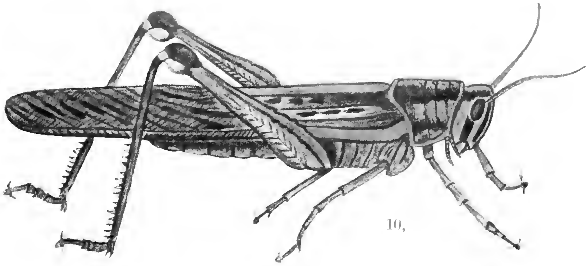
The essential features of this locust are that it lives in all stages only six months, that its hoppers pack into swarms and move about, and that it is primarily a desert insect, an insect that lives and breeds in dry hot places and not in the moister parts of India where vegetation is abundant. In habits and colouring it is specially adapted to this life, and we might aptly term it the "desert locust" in distinction to the second Indian locust. The fact that the hoppers pack into swarms and move is sufficiently well marked to enable this locust to be immediately recognized in this stage; no one can mistake an army of these little dark coloured insects as they pour along the soil, and there need be no hesitation in identifying such a swarm as the North-West Locust. (Plate XVIII.)

The Bombay Locust* is so called as, in its capacity of a locust, it occurs chiefly on the Western Ghats and in neighbouring districts. Its last occurrence on a large scale was in 1903-04, and an account of its habits was published in 1906.† This locust is represented in Plates XVI, XVII. It will be seen that its colouring varies extremely, and this is the principal reason why it has been confused in the past. This locust is first seen in October, when swarms are found flying: at this time it has the colouring shown in Plate XVII. Normally the insect retains this colour until death. In almost any part of India that is sufficiently moist and wooded, it will be found singly, in small numbers, just like any ordinary grasshopper. In some years, as in 1903, it becomes abundant, assumes the instincts of a locust, gathers together in loose swarms and migrates; unfortunately we know little of this locust except from the 1903 outbreak; in that year these swarms concentrated on the Western Ghats, as they did in previous recorded outbreaks: the migration to the Ghats took place in November, and it was found that these locusts had

* At present known to Science as *Acridium succinctum*, Linn., with some doubt. The family is undergoing revision at the present time.

† Memoirs of the Agricultural Department, Entomology, Vol. I, No. 1.

PLATE XVI



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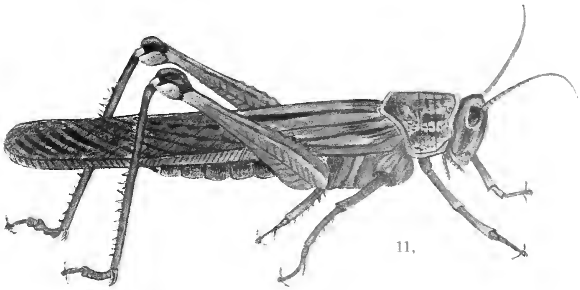

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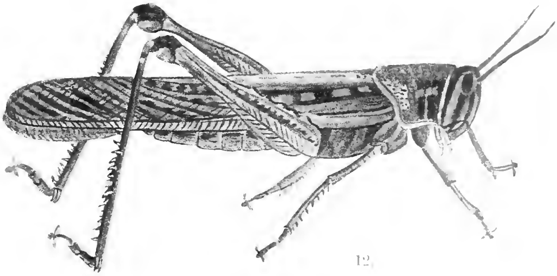


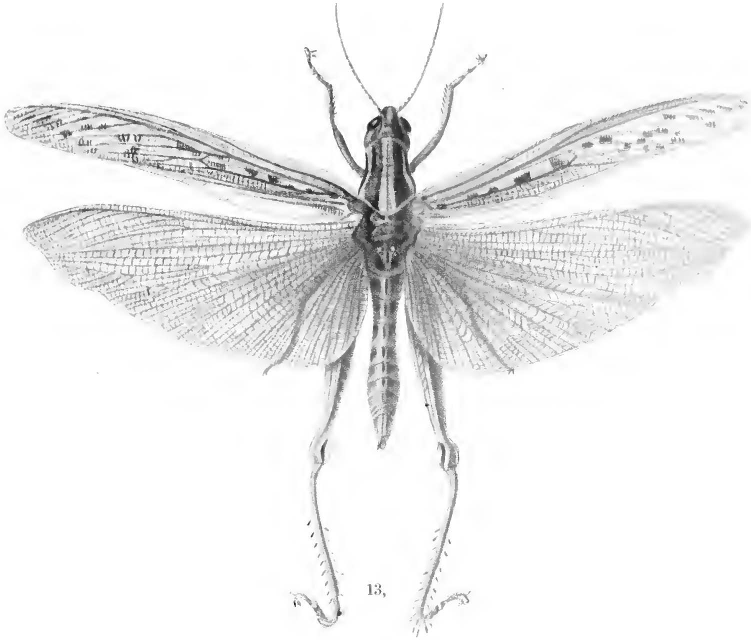
12,

THE BOMBAY LOCUST.

K. H. M. G. del.

Engraved and Printed by The Calcutta Phototype Co (Thacker Spink & Co.)

PLATE XVII



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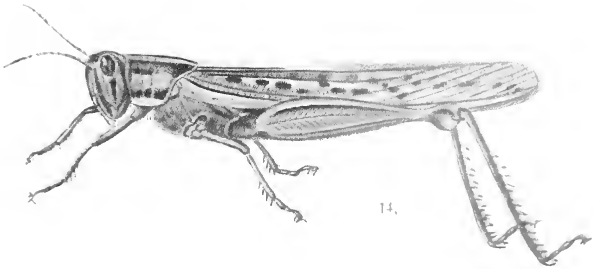


14,

THE BOMBAY LOCUST.

Engraved and Pr...
by The Calcutta P...

become a vivid red, as shown in Plate XVI. Fig. 12 ; we may call this the "Swarming Colour," and we surmise its object to be simply to facilitate swarming, the stragglers being able to see from a long distance and regain the swarm. From November to March, these locusts moved about the forests in great swarms, defoliating the trees; in March they commenced to move out, and they spread as far north as Ahmedabad and Udaipur, as far east as Nagpur, and south-east into Madras districts. The swarms then broke up, the locusts spread out singly and were widely distributed over a great area. In some the red colouring gave place to a "dry grass colour," the dull yellow brown of dry grass, but in the majority the red colouring remained more or less vividly until this second migration was over; in May the colouring of all changed to the dark colour shown in Plate XVI, Fig. 13, and when the rains came, egg-laying commenced. The colouring was then of extreme value, as the locust settling on the wet ground was very difficult to see. We call this the "wet ground colour," since it served the purpose of concealing the insect when settled on the wet soil. An egg-laying locust has many enemies, especially birds, and just as the North-West Locust turns to the colour of sand, so this locust assumed the hues that best enabled it to remain unseen on the earth when laying eggs. Egg-laying takes place after the first fall of rain in June—July, the eggs hatch in six to seven weeks to hoppers and the original locusts were by this time all dead. The hoppers were found to be green, did not pack into swarms, but remained singly in the long green grass just as ordinary grasshoppers do. In Plates XIV, XV we figure the hoppers in all stages. These figures were painted from specimens very carefully reared during the outbreak of 1903-04. Had not specimens been reared in cages and kept alive from stage to stage, it would have been impossible to tell which of all the hoppers caught were really of this locust. A great variety of insects were caught and sent in as being the hoppers of this insect. The senders would have avoided this confusion if coloured figures of the hoppers had been available at the time. These plates will enable

them to be immediately recognized when this locust occurs again. The hoppers moult as a rule seven times and then are winged, emerging in October.

The essential features of this locust are :—

(1) It is normally a grasshopper, but when excessively abundant behaves as a locust.

(2) It breeds normally in forest areas, and most abundantly in the forests of Kanara and Goa.

(3) Its total life is one year.

(4) Hoppers do not pack into swarms.

(5) The eggs are not laid in one place by a number of locusts but, as a rule, are scattered, each locust laying in any spot it finds suitable.

(6) The locust changes colour twice.

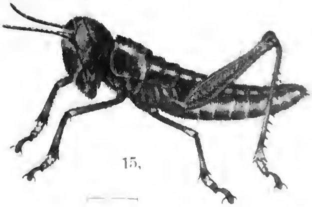
(7) Eggs are always laid in wet soil, not in dry earth or sand.

(8) Hoppers die in a dry atmosphere and can live only in very moist places.

The description given above shows how great is the distinction between these two insects and how important it is to be able to distinguish the habits and appearances of each In the dry areas of Northern India, from Sind to the Punjab, in Kathiawar, and in Northern Rajputana, the North-West Locust alone occurs very commonly. The Bombay Locust may be found in forested areas, such as Kulu (and is doubtfully recorded as occurring there in vast swarms), but will not be found, as a rule, where the North-West Locust breeds.

From Ahmedabad southwards, through Gujarat, Central India, the Central Provinces and Berar, both locusts occur, and it is in these areas particularly that it is all-important to be able to distinguish which locust composes the swarm There has been the greatest confusion in the past, and in 1903, when swarms of the Bombay Locust were flying south to the Ghats, swarms of the North-West Locust flew over from Kathiawar to Surat, crossing the path of the former, and passed on eastwards into India, giving rise to the belief that the locusts were moving east.

PLATE XVIII.



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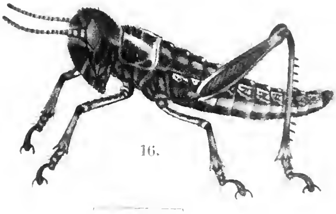

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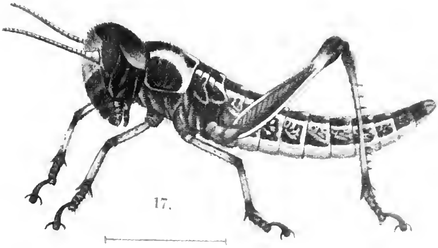

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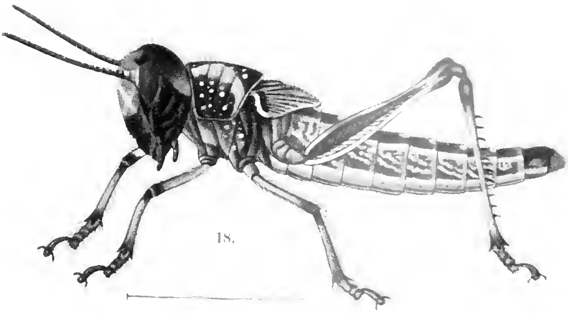
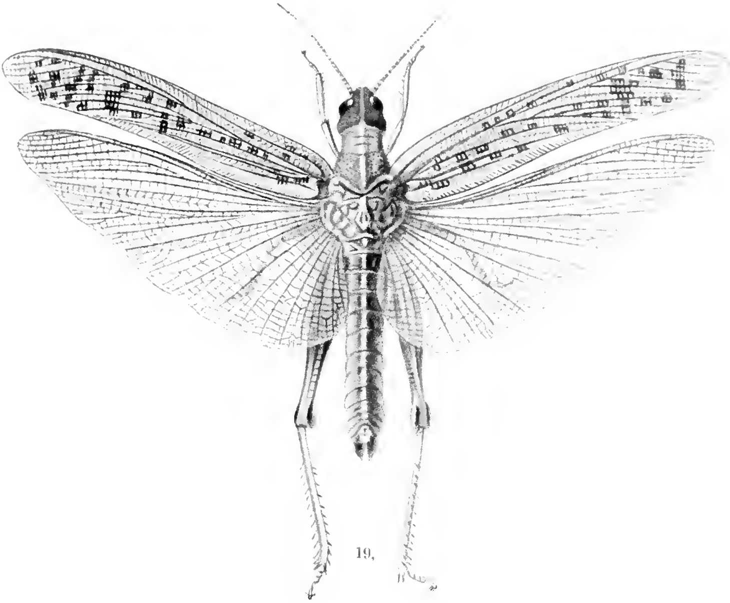


18.

THE NORTH-WEST LOCUST.

Engraved and Printed
by The Calcutta Phototype Co.
(Thacker, Spink & Co.)

PLATE XIX.



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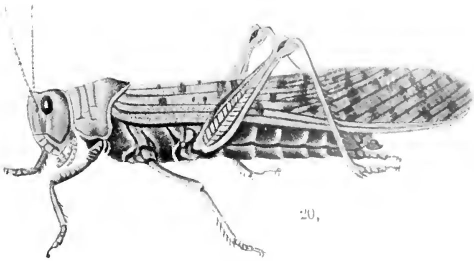


20,

THE NORTH-WEST LOCUST.

Engraved and Printed
by The Calcutta Phototype C
(Thacker Spink & Co.)

So far as the scanty records go, the locusts, south of a line drawn from Bombay to Calcutta, should be the Bombay Locust as a rule, but what the Locusts of Madras really are, does not seem to be certain. In Bengal and Assam, either locust might occur, but we believe that the Bombay Locust is not there known in swarms, but that the locusts are the North-West Locusts *which do not breed in so moist a climate.*

A great deal has been written about these two locusts, and we have indicated the salient points in the lives of each ; but there are some points on which we are still ignorant. This is particularly the case with regard to the movements of these swarms of locusts, and unless far more full and accurate records can be obtained, we shall not be able to trace individual swarms across India. The peculiar migrations of the North-West Locust are still largely shrouded in mystery ; when these locusts penetrate into the moist areas of Lower Bengal and Assam, what do they do ? Do they seek a hot dry area in which to lay eggs ? Do they turn back towards North-West India, or do they push on in the vain hope of finding sandy deserts ? These and other questions remain unanswered to this day and much remains to be learnt.

The North-West Locust is also the locust of other countries but, so far as we know, the Bombay Locust is not known to occur in swarms elsewhere than in India. The Central Asian Locust occurs in India, but we believe never in swarms. One of our commonest insects is the Black spotted Grasshopper, figured in Plate XX ; in 1903-04 this was constantly sent in as a locust ; there is no *definite authentic* case of this insect having been found in a swarm ; it has been found attached to swarms of the Bombay Locust, but no swarm composed of this grasshopper has been recorded. We figure it here because it is the insect most likely to be taken for a locust ; it is the nearest in structure and appearance to the Bombay Locust of all our common grasshoppers, but it *never changes colour*, is common throughout the cultivated parts of India and normally feeds on cotton leaves.

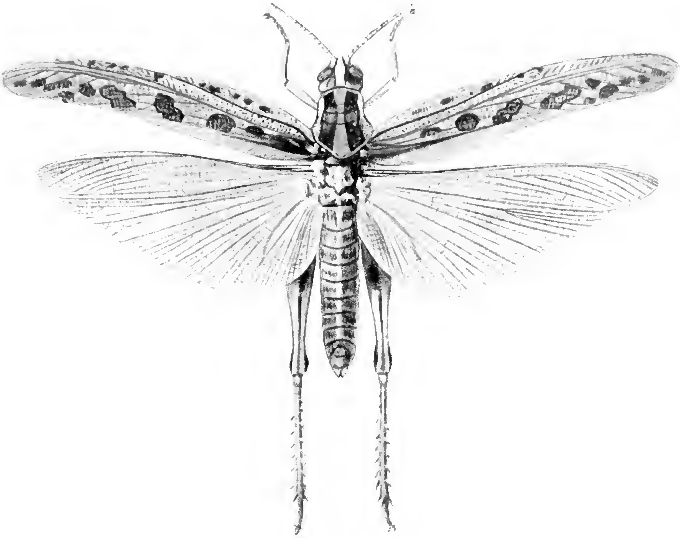
In all cases of a doubtful locust, compare the specimen with this plate: open the wings and note if the large delicate lower wing is yellow.

Unfortunately there is no single structural feature that separates a locust from a grasshopper, and the reader will find large insects that look like locusts, but do not agree in appearance with the insects portrayed here. Unless they are in swarms, they are not locusts; if they are in swarms, care is required to make sure that one gets the real insect composing the swarm. It is a surprising fact that grasshoppers often attach themselves to the fringe of a locust swarm, and it is very easy to assume that one of these insects, which one finds after a swarm has passed or which settles near a swarm, is the real article, when it is only a chance straggler or a hanger-on.

We do not propose to say anything about remedies. To deal with locusts is not a matter for an individual, but a question of co-operation and effort on a large scale. The North-West Locust is dealt with successfully by simple means in Northern India, and an account of the measures adopted against the Bombay Locust is on record.

We trust that any reader of the Journal who sees a swarm of locusts and finds that it is the Bombay Locust will help by reporting it *wherever he may be*: that anyone finding a swarm of the North-West Locust anywhere *outside the drier areas of the Punjab, Sind, Rajputana and Kathiawar* will report the fact and state the colour of the locust: and that anyone so lucky as to find a swarm of locusts not agreeing with those figured here will send as many as possible with full details: and finally, should anyone be so fortunate as only to *see* in a swarm of locusts that are green or any other colour than yellow, red or pink, he will render valuable assistance by reporting the matter by wire specifying the exact locality.

PLATE XX.



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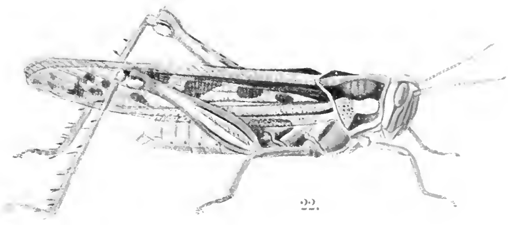


22.

THE BLACK-SPOTTED GRASSHOPPER.

Engraved and Printed

PLATE XXI.

A. J. I.

STEAM THRASHER AT WORK.

A.—Sifting Riddle with blower on which the *bhusa* falls. B.—Bruising and chaffing apparatus. C.—Self Feeder.
D.—Cleaned grain delivered.

be of general interest, trials were arranged this year to test it against the country method of treading out by cattle.

The thrasher, which was supplied by Messrs. Marshall, Sons & Co., Ld., Gainsborough, has been specially designed for use in India. (Plate XXI.) It is built of seasoned teak and is mounted on large travelling wheels which enable it to be readily moved from place to place. With a thrashing drum three feet wide it requires a portable engine of five nominal horse power to drive it, but at Pusa an old eight-horse-power engine used for pumping is employed. The characteristic feature of the thrasher is a double roller straw chopping and bruising apparatus by which the straw, after leaving the thrashing drum, is converted into *bhusa*. In connection with this apparatus there is a separate attachment (supplied or not as desired) fixed in front of the machine which consists of a large sifting riddle, with a blower working underneath, designed to intercept any grain which may have passed over with the straw. The thrasher is fitted with a self-feeding arrangement consisting of endless canvas conveyors by which the corn is carried to a revolving barrel fitted with spikes which, with the assistance of oscillating forks fixed overhead, feeds it evenly into the thrashing drum. The grain is delivered into sacks cleaned and graded into three qualities, or all of one quality, as desired. Special drums can be supplied for thrashing other crops, such as paddy or rapeseed. The cost of the thrasher, landed at Calcutta, with the improvements above described, was about Rs. 4,500.

The crop used for the trials was oats, neither wheat nor barley being available in sufficient quantity. Unfortunately, the weather this season was far from favourable for thrashing. April in Behar is usually a hot rainless month with dry west winds prevailing and the humidity very low. Under these conditions, the grain is readily separated from the dry brittle straw and the latter under treading soon breaks up into *bhusa*. With a moist east wind, the grain is not readily separated and the straw becomes tough and breaks up with difficulty. Usually thrashing is postponed until the west winds have well set in. This year the

west winds were late in arriving and when they did come did not blow steadily but constantly alternated with moist east winds. The results of the trials, therefore, are not good for either of the methods tested, but they possess a certain comparative value. The trials extended over seven days. It was hoped to keep separate records for east and west winds, but in practice this was found to be impossible on account of the frequent changes.

The treading out by bullocks was done in the ordinary way and need not be described. (Plate XXII.) The total quantity of grain trodden out by three pairs of bullocks in seven days was thirty-seven and a half maunds. Taking the cost of bullocks at six annas per pair and the two men working in attendance at two and a half annas each, this works out to an average cost of about four and a half annas per maund of grain. To this one anna per maund has to be added for winnowing, making the total cost five and a half annas per maund. This is rather a heavy charge for winnowing, but the wind was fitful and uncertain.

The unfavourable weather was more disadvantageous to the thrasher than to the country method of thrashing. With moist weather jamming was frequent, not in the thrashing drum but in the bruising rollers described above, and whenever this took place, the engine had to be stopped and the obstructing material removed, involving considerable loss of time. But changes of wind were more fruitful of trouble than even a steady east wind, chiefly on account of their action on the leather belts by which the various parts of the thrasher are driven. With a dry wind these get slack, with a moist wind tight, involving in either case considerable loss of power and loss of time in making the necessary adjustments. Further, the alternate expansion and contraction imposed a heavy strain on the belts as a result of which they frequently broke. It might be worth while for makers of thrashers for India to consider whether it would not be possible to obviate this source of trouble by providing some substitute for belting such as endless chains of the bicycle pattern. The greater initial cost would, no doubt, be the chief obstacle. On the other hand, it must be remembered that if one belt out of the dozen

PLATE XXII.

A. J. I.

TREADING OUT THE CORN.

or so used breaks, the thrasher must stop work until this is repaired or replaced. Breakages of other parts of the thrasher were few and insignificant, and were usually caused by some foreign substance entering along with the corn.

In the trials the normal working day for the thrasher may be taken as eight hours, but on account of stoppages for the reasons detailed above, it was actually reduced to an average of six and a quarter hours over the seven days. The total amount of cleaned grain delivered in this time was one thousand and ninety-seven maunds, giving an average of one hundred and fifty-seven maunds per day or twenty-five maunds per actual working hour. This is a very fair outturn, but low when compared with that of thirty-four maunds obtained in a measured hour when a good west wind was blowing. Coal and wood were used as fuel on different days. The consumption of the former averaged twelve maunds, of the latter twenty-four maunds per day. With coal selling at seven annas per maund and wood at twelve rupees per hundred maunds, this shows a distinct advantage in favour of the latter, but the difference is hardly appreciable on the total cost of working the thrasher, and with wood as fuel the risk of fire is considerably greater. The following abstract shows an average daily cost:—

	Rs.	A.	P.
1 Mistri @ Re. 1	1	0	0
1 Fireman @ Re. 0-3	0	3	0
1 Oilman @ Re. 0-3	0	3	0
6 Men drawing and carrying water for boiler @ Re. 0-2-6	0	15	0
6 Men forking and feeding @ Re. 0-3	1	2	0
2 Men keeping thrasher clear of *bhusa* @ Re. 0-2-6 ...	0	5	0
2 Men removing caving, &c. @ Re. 0-2-6	0	5	0
2 Men attending grain bags @ Re. 0-2-6	0	5	0
12 maunds coal @ Re. 0-7	5	4	0
3 seers lubricating oil @ Re. 0-5	0	15	0
Depreciation and repairs of thrasher @ 10 % on Rs. 4,500, 60 days per annum being taken as working period ...	7	8	0
Depreciation and repairs of Engine @ 5 % on Rs. 4,000, 100 days per annum being taken as working period (as it is also used for other work)	2	0	0
Belting @ Rs. 100 for season of 60 days	1	10	8
Interest on capital (Rs. 8,500) @ 10 %	14	2	8
TOTAL Rs.	35	14	4

This for one hundred and fifty-seven maunds gives an average cost of three annas eight pies per maund, or if the item for interest be omitted, two annas two pies per maund.

The straw bruising apparatus worked quite satisfactorily, producing *bhusa* in every way equal to that given by treading. Except for jamming in moist weather it gave no trouble and this was remedied by lighter feeding. The sifting riddle working in connection with this recovered quite an appreciable quantity of grain, especially in moist weather when thrashing is imperfect, and quite repays its cost. The self-feeder worked admirably and largely gets over the very great difficulty of training coolies to feed evenly and uniformly. It is probable that it increases the daily outturn by at least twenty-five per cent. The grain delivered was a nice clean sample, quite free from the dirt found in that removed from the thrashing floor.

One point in regard to the working of thrashers in hot dry weather requires special notice, and that is the considerable risk of fire. This may arise, either from overheated bearings or from a spark from the engine or even a hookah falling on to the dry straw. In several instances in Behar thrashers have been completely burned down in this way, and some planters for this reason will only have machines built on an iron framework. The risk of fire, however, is not very great if reasonable precautions are taken. At Pusa the practice is to stop the engine at the end of every hour to examine and oil all the bearings. The engine is set up in such a way that no sparks will blow towards the thrasher or the straw, smoking in the neighbourhood is strictly prohibited, and as a final precaution, a score or so of earthen pots or empty kerosine tins are always kept alongside filled with water.

Looking at the results described above, it is reasonable to consider that, in certain portions of India, such as the Punjab and the Central Provinces where large areas of wheat are grown, there may be a future for the steam thrasher. Its great initial cost would no doubt make it prohibitive on all but very large single holdings, but were it worked by a business firm on the peripatetic system familiar in many parts of England, there seems

to be no reason why it should not become popular and successful. It is rather an elaborate machine but a good native *mistri* will readily master its working and management. That at Pusa was imported in sections and completely set up by the *mistri* on the farm establishment, with no other assistance than that derived from an illustrated catalogue, and it has since been under his entire control. All the parts are standardized and numbered and easily obtained from the manufacturing firm, and with a small stock in hand of such spare parts as are likely to most frequently give way, no serious breakdown need be feared.

At Pusa the thrasher is employed for thrashing not only oats but also wheat, barley, paddy and *arhar* (*Cajanus indicus*). Next year it is intended to conduct similar trials with some or all of the latter crops.

THE MONTGOMERY AND SIND BREEDS OF CATTLE.

BY J. MOLLISON, M.R.A.C.,

Inspector-General of Agriculture in India,

AND

L. FRENCH, I.C.S.,

Offg. Director of Agriculture, Punjab.

THE Montgomery cows of the Punjab are superior as milk producers to those of any other Indian breed. The only others that rival them in milk production are *Hansi* cows and those bred in Lower Sind. The latter have many characteristics in common with Montgomery cattle. Both breeds are probably of common origin. Brief descriptions of each are given in this article.

The Montgomery cattle are locally known as the *Sahiwal* or *Teli* breed. The district has a very light rainfall with large upland stretches of waste land sparsely covered with poor scrub and grass. It is surprising that a superior breed of milk cattle should have been produced under these circumstances.

The best Montgomery cattle are bred in the tract known as the "Ganji Bar," which lies chiefly in the Dipalpur, Gugera and Montgomery Tahsils of the Montgomery district. The derivation of the word "Bar" is unknown, but its meaning is well understood in the Western Punjab. It signifies an upland tract or high plateau lying between two rivers and fringed on either side by riverain. "Ganji" means bald, and is appropriately applied to the tract on account of the general absence of

PLATE XXIII.

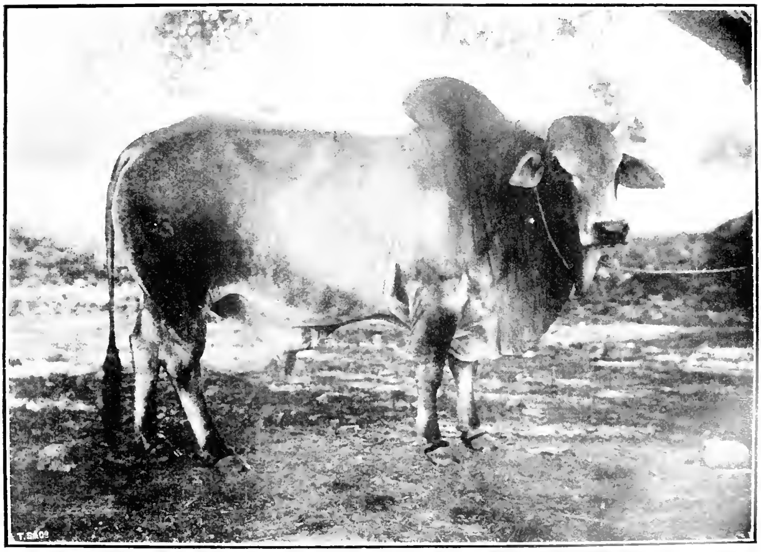
A J I

Pusa Herd of Montgomery Cattle.

PLATE XXIV.

MONTGOMERY BULL.—(AMRITSARI).

STUD BULL, PUSA HERD.



A. J. I.

Measurements.

Height at hump.	Height behind hump.	Girth.	Length from behind hump to point of pubis.	Length of quarters.	Width of pelvis.	Length of ears, outside curve.	Length of horns, outside curve.	Circumference of horn at base.	Width of forehead (Greatest convexity measuring from the base of each horn.)	Length of face from poll to muzzle.	Length of canon.	Girth of canon.	Height at croup.
4′–6½″	4′–1″	6′–3½″	4′–11″	1′–7″	1′–6½″	1′	5¼″	7½″	10½″	1′–7½″	8″	7½″	4′–3″

vegetation. This characteristic impresses itself on those travelling by rail from Lahore to Multan, for the main line to Karachi traverses the heart of the "Ganji Bar."

Montgomery shares with Hissar (whence the *Hansi* breed comes) the reputation of being the most arid district of the Punjab. The "Bar" is comprised almost entirely of waste lands which are the property of the Crown. There are four distinct tracts of the "Bar" in the Montgomery district, and the highest of these is the "Ganji Bar." As might be expected, this is also the driest tract. Vegetation is scanty and where it exists of a stunted kind, considerable areas are thoroughly impregnated with alkaline salts.

The annual rainfall of the "Ganji Bar" is 10″ or less. The depth to subsoil water is 60′ or more. Well water is occasionally good, but just as frequently is brackish. The shade temperature varies from a maximum of 120° F. in May to a minimum of about 30° F. in December.

In seasons of favourable rainfall grass grows in fair abundance, except on the *usar* patches which grow nothing. On the best land there are stunted trees consisting chiefly of *Van* (Salvadora oleoides), *Jand* (Prosopis spicigera), *Karali* (Capparis aphylla) and *Farash* (Tamarix orientalis). The best and most common grasses are *Chhimbar* (Eleusine flagellifera), *Khabbal* or *Dubh* (Cynodon Dactylon), *Dhaman* (Pennisetum cenchroides) and *Palwahan* (Andropogon annulatus).

In circumstances such as those above described, agricultural life has been less profitable than pastoral, and the Mohammedan denizens of these arid upland tracts have hitherto made a living entirely from their herds of *Sahiwal* cattle and occasional flocks of sheep and goats. They have led a purely nomadic life. It is significant that the best professional breeders of cattle in all parts of India lead wandering lives and rarely settle to the hard routine work of arable cultivation.

In the high tract between the Ravi and the Sutlej there are a few cattle camping grounds more or less permanent in character. These usually consist of a circle of sheds placed

conveniently near a deep and narrow well from which with great labour drinking water is obtained. The herds of cattle graze in the vicinity from the commencement of the rains until the end of February. The grazing then usually becomes insufficient and the pasturage on the banks of the rivers has to be utilized. But occasionally the cattle are able to remain in the "Bar" until the next rainy season approaches. The natural grazing is supplemented by *bhoosa*, which is now easily obtainable, on account of extended canal irrigation. Formerly in seasons of exceptional drought the nomad cattle owners had to take their herds great distances to obtain sufficient grazing. The grasses of the "Ganji Bar" are said locally to be "taqatwala" *i.e.*, "strength giving" and are considered far superior to the grasses which grow on riverain lands.

Montgomery cows being good milkers have been sent freely to many parts of India and have been even exported from India. A vast extension of canal irrigation has taken place in the neighbouring districts across the Ravi river, and many good cows have been taken or sold by their owners into the new Chenab Canal Colony. A steady and rising demand for them is also maintained by the professional milk dealers of Lahore, Multan and Amritsar, and in consequence a scarcity in supply is already being experienced. A herd is maintained at Pusa to test the milking quality of this breed and to supply the European and Native establishments with milk.—(Plate XXIII.)

These cattle are apparently easily acclimatized to conditions which differ greatly from those of the Montgomery district. At Pusa, the young male stock are readily saleable and have been found active and generally useful for ordinary agricultural work in Behar, though in the Punjab they have no great reputation as plough cattle.

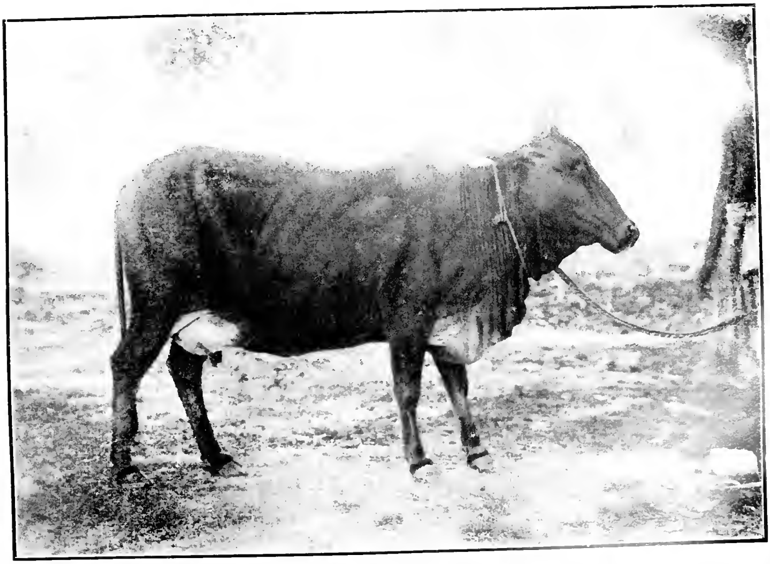
Representative specimens of the Pusa herd are illustrated in this article, and measurements are given for each animal represented.—(Plates XXIV—XXVI.)

Montgomery cattle are small, shapely and short-legged with fine clean cut heads, fairly short horns, small alert ears,

PLATE XXV.

MONTGOMERY COW.—(SOORMI).

NO. 21, PUSA HERD.



A. J. I.

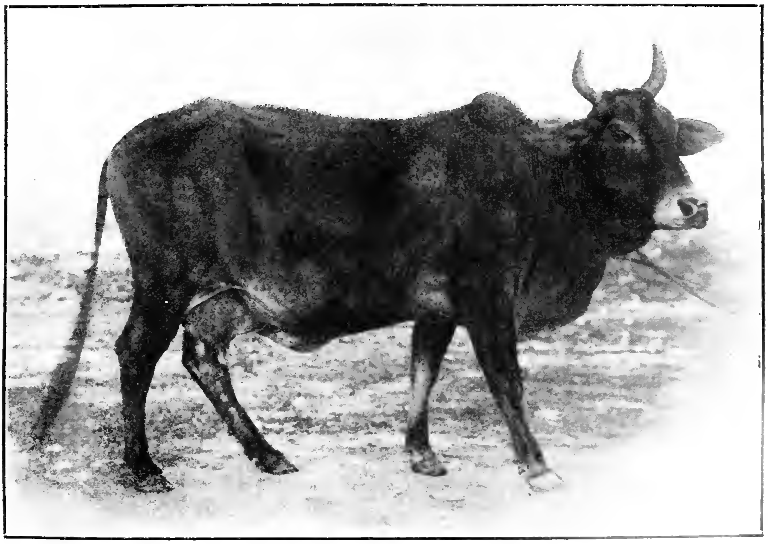
Measurements.

Height at hump.	Height behind hump.	Girth.	Length from behind hump to point of pubis.	Length of quarter.	Width of pelvis.	Length of ears, outside curve.	Length of horns, outside curve.	Circumference of horn at base.	Width of forehead. (Greatest convexity measuring from the base of each horn.)	Length of face from poll to muzzle.	Length of canon.	Girth of canon.	Height at croup.
4′—½″	3′—10½″	5′—4½″	3′—7″	1′—4½″	1′—4½″	10¾″	9″	7″	8″	1′—7½″	7½″	6½″	4′—1½″

PLATE XXVI.

MONTGOMERY COW.—(KHOORMI).

NO. 22, PUSA HERD.



A J I

Measurements.

Height at hump.	Height behind hump.	Girth.	Length from behind hump to point of pubis.	Length of quarter.	Width of pelvis.	Length of ears, outside curve.	Length of horns, outside curve.	Circumference of horn at base.	Width of forehead. (Greatest convexity measuring from the base of each horn.)	Length of face from poll to muzzle.	Length of canon.	Girth of canon.	Height of croup.
3'—11"	3'—10"	5'—1½"	3'—8¼"	1'—5"	1'—4½"	10½"	9¼"	6¼"	7"	1'—7¼"	7½"	6¾"	4'

thin necks, fine leg bones, small feet and exceptionally long thin tails. The back is generally highest at the croup. The skin is thin and the coat fine. The colours vary, but most are dark red, pure white or grey. Spotted cattle are, however, fairly common. Average cows giving 16 lbs. of milk daily, are worth 50 or 60 rupees each. A first class cow is worth Rs. 100 or more. The very best cows yield about 30 lbs. of milk per day when in full profit. The udder is large, well shaped, with fairly large regularly placed teats. Prior to the extension of the Chenab Canal, through the neighbouring "Sandal Bar," good cows were locally worth only Rs. 30 or Rs. 35 each.

The breeding of Montgomery cattle is likely to suffer unless special precautions are taken to maintain the purity of the breed, because the extraordinary prosperity of the Chenab Colony across the Ravi, has diverted the attention of the Nomadic "Bar" tribes to the profits derivable from agriculture when assisted by canal irrigation. It is also to be remembered that the whole of the "Bar" tracts of the Montgomery district are destined within the next few years to receive irrigation from the projected Lower Bari-Doab Canal. Formerly selection was carefully practised in breeding. Only the best bulls were kept. Rivalry amongst owners forbade their parting with their best stock except to blood relations. The superiority of the breed is largely due to these causes.

Sind Cattle.—There is similarity in type between Montgomery cattle and those bred in Lower Sind. The latter are found between Hyderabad and Karachi. The owners are nearly all Mohammedans and do not usually cultivate land. They move their cattle from one jungle pasture to another as occasion requires. Hay in quantity is stored by most cattle owners. When in milk, the cows get in addition to grass or hay, concentrated food consisting of cotton seed, oilcake, bran or pulse meal. The owners are particular in selecting their bulls.

Sind cattle show considerable variety in type and colour. Many good Sindi cattle are spotted in colour. The majority are red, a deep rich red with occasional white markings, a white mark

on the face, white ankles or a white udder being very common. These cattle are of medium size. The frame is long, deep, massive and is supported on short well-set legs. The shank is round and coarse and the feet large and soft. The long level quarters, deep muscular thighs, wide loins and large paunch are characteristics usually found in good milk cattle. The heavy head, thick short neck and ponderous dewlap are, however, points not usually found in superior milk cattle. The horns are generally coarse, rather long and blunt-pointed. The ears are fairly long and somewhat pendulous. The eyes have a sleepy placid appearance indicating the docile temperament for which the breed is noted.

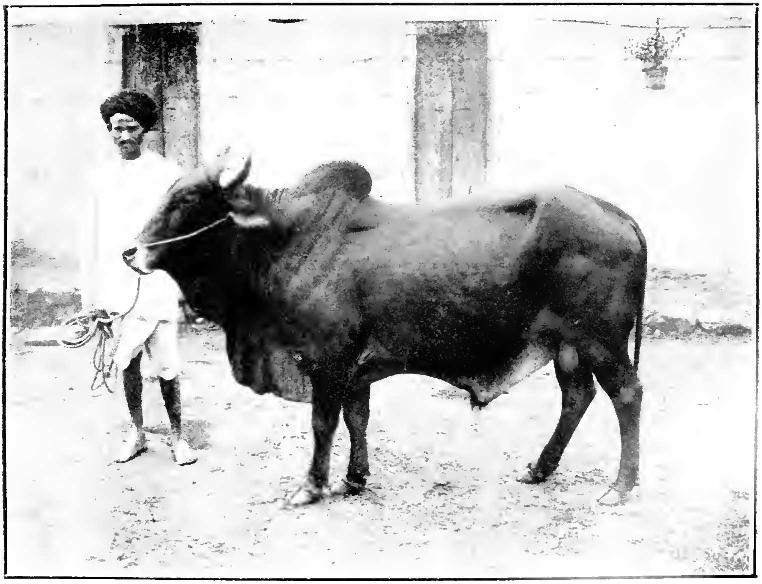
Good cows in Sind are worth about Rs. 60 each. The best cows give about 20 lbs. of milk per day. A pair of good strong work bullocks can be bought at Rs. 60 to 80. They are usually too slow for light quick road work and not big enough for heavy slow cartage.

The two illustrations with measurements represent typical specimens of a bull and cow.—(Plates XXVII—XXVIII.)

PLATE XXVII.

SIND BULL.

KIRKEE FARM HERD.



A J I

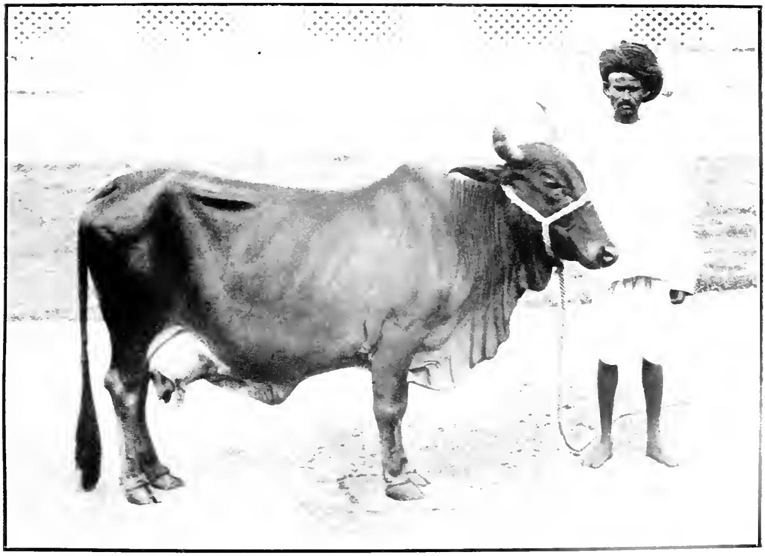
Measurements.

Height of hump.	Height behind hump.	Girth.	Length from behind hump to point of pubis.	Length of quarter.	Width of pelvis.	Length of ears, outside curve.	Length of horns, outside curve.	Circumference of horn at base.	Width of forehead. (Greatest convexity measuring from the base of each horn.)	Length of face from poll to muzzle.	Length of canon.	Girth of canon.
4′—8″	4′—2″	5′—8″	3′—5½″	1′—4″	1′—3½″	11½″	11½″	9½″	10½″	1′—7″	6″	7″

PLATE XXVIII.

SIND COW.

KIRKEE FARM HERD.



A J I

Measurements.

Height at hump.	Height behind hump.	Girth.	Length from behind hump to point of pubis.	Length of quarter.	Width of pelvis.	Length of ears, outside curve.	Length of horns, outside curve.	Circumference of horn at base.	Width of forehead. (Greatest convexity measuring from the base of each horn.)	Length of face from poll to muzzle.	Length of canon.	Girth of canon.
4′—2″	3′—10″	5′—6″	3′—8″	1′—4″	1′—4″	10½″	1′—1″	8″	9″	1′—7½″	5″	7″

PROPOSED GRASS-LAND EXPERIMENTS IN INDIA.

By J. MOLLISON, M.R.A.C.,

Inspector-General of Agriculture in India.

MANURIAL and other experiments on grass-lands in England have yielded valuable and very definite results. Such experiments are worth trying in India, where good pasture lands exist, or where they can be established.

The military dairy farm grass-lands in various Indian cantonments have been greatly improved by the trenching of night-soil and city-refuse in a systematic and entirely sanitary manner, and by the establishment on the improved land of good varieties of indigenous grasses.

There can be no question that we have in India very superior and very inferior grasses in the pastures of every district of moderate or light rainfall. Professor Middleton, who is now the Practical Adviser to the Board of Agriculture in England, identified in Gujarat, whilst employed in the Baroda State, over a hundred varieties of grasses. This work of identification and the work of estimating the feeding value of numerous grasses has not yet been seriously undertaken in India. The work is important, and will claim early attention. We know, however, that many of the grasses which commonly grow are inferior in value, and that leguminous herbage, which has generally high feeding value, is extremely sparse.

The quality and character of herbage on any class of soil depends greatly on natural conditions. In fighting the last famine in Gujarat and in trying to keep a few of the far-famed Gujarati cattle alive, I came very definitely to the conclusion that the rank grass which grew in districts of ordinarily heavy

rainfall was poor in nutritious stuff when cut in the ordinary way when dead ripe. On the other hand, I found that the grass obtained from districts of moderate rainfall had very considerable feeding value even when overripe.

It is probable that the natural climatic conditions in the plains of India may preclude the possibility of improving natural pastures, as the soil and climate determine largely the character of natural and cultivated vegetation. I found in Kashmir, lucerne and every ordinary kind of clover growing wild, but it would be difficult, if not impossible, to establish such vegetation in the plains of India.

In attempting to improve the better descriptions of our grass-lands, the first steps should be (*a*) to improve the character of the soil, if possible, as in military cantonments ; (*b*) to introduce by sowing such indigenous grasses as have superior feeding value and are of vigorous habit of growth ; (*c*) to stimulate by sowing seed and otherwise the growth and spread of useful indigenous leguminous herbage ; (*d*) to test on improved land the effects of various manures on the quality and outturn of produce.

In England, at various Experimental Stations, it has been definitely proved that the quality and character of natural pasture can be fundamentally changed by the application of particular manures.

Basic slag and other cheap phosphatic manures have given astounding results on poor clay land pastures in England. The price of these and other artificial manures in India is, at present, so high and the need for economy in agriculture is so great, that it is uncertain whether such costly artificial manures should be tested. The production of such manures in this country may be anticipated as the agricultural and trade resources are developed. I, therefore, advocate the experimental use on a small scale of such manures.

India is extremely rich in oilcakes. It has been proved that castor cake and non-edible cakes got from natural forest products, such as the seeds of *Karanj* (Pongamia glabra) and *Neem* (Melia Azadirachta) are very valuable manures. These non-edible

oilcakes have really less manurial value than such edible cakes as groundnut, rape seed, niger seed, safflower, etc. At the present stage of agricultural advancement in India, such edible cakes can be economically used as manure, because when fed to cattle the dung is largely used as fuel and the urine largely runs to waste. Very little, therefore, of manurial value is returned to the land.

Edible as well as non-edible cakes should, therefore, be used in experiments. For these purposes, selections should be made from the kinds of cake which are locally the cheapest.

Oilcakes produced in the country *ghani* act very quickly, whereas those produced in hydraulic press mills from seed treated by superheated steam act very slowly. This superiority is due to the fact that the nitrogenous portion of the seed becomes coagulated by heat and therefore can only be utilized in the soils slowly for plant nutrition.

At Pusa we keep a breeding herd of cattle and a flock of sheep, and it is important to determine whether our pasture lands can be improved by the means indicated above. Mr. E. Shearer, Imperial Agriculturist, Pusa, has framed a scheme of manurial and other experiments which will be carried out at Pusa.

The manurial scheme is tabulated below :—

Manurial Scheme for Pasture Experiments.

No.	Details.	Remarks.
1	No manure.	To be applied once ; thereafter at the end of 3 years or other date to be subsequently fixed to be followed by 10 tons farm yard manure repeated every fifth year.
2	Superphosphate = 150 lbs. Phosphoric acid per acre.	
3	Basic slag = 150 lbs. Phosphoric acid per acre.	
	Superphosphate = 100 lbs. Phosphoric acid per acre.	
5	Superphosphate = 100 lbs. Phosphoric acid per acre. Kanit = 50 lbs. Potash. per acre.	
6	Rape cake = 1 ton per acre.	To be applied every fifth year.
7	Castor cake = 1 ton per acre.	
8	Ammonium Sulphate = 50 lbs. Nitrogen per acre.	To be applied every year.
9	Nitrate of Soda = 50 lbs. Nitrogen per acre.	
10	Superphosphate = $33\frac{1}{3}$ lbs. Phosphoric acid per acre.	
11	Superphosphate = $33\frac{1}{3}$ lbs. Phosphoric acid per acre. Kanit = 25 lbs. of Potash per acre.	
12	Superphosphate = $33\frac{1}{3}$ lbs. of Phosphoric acid per acre. Ammonium Sulphate = 50 lbs. of Nitrogen per acre.	
13	Superphosphate = $33\frac{1}{3}$ lbs. Phosphoric acid per acre. Ammonium Sulphate = 50 lbs. Nitrogen per acre. Kanit = 25 lbs. Potash per acre.	
14	Farm Yard manure = 3 tons per acre.	

The extent of *even* land available in the pasture land at Pusa is limited and the proposed experimental plots are, therefore, smaller than is desirable. The area in one block will be divided into fourteen plots each of 1 acre. One-fourth of each plot will be fenced off and cut annually as hay, the remaining three-fourths will be grazed by cattle and simply kept under observation.

I should like to see this scheme of experiments arranged for in other parts of India, particularly on Government Cattle-Breeding and Dairy Farms. It should be modified to suit local conditions, etc. If possible, the plots should be larger than those at Pusa.

As bearing on the improvement of pasture by actually sowing seed, Mr. Shearer says: "The Indian leguminous plants in pastures are not nearly so numerous nor so valuable for their soil improving and feeding qualities as those found in England, but fortunately they are not altogether absent. In Behar one legume in particular which would seem to correspond very closely with trefoil or yellow clover (Medicago lupulina) is found where there are no rough jungle grasses like *Rari* (Saccharum spontaneum) and *Dabhi* (Imperata arundinacea). Yellow and white melilot are also found as weeds in the cultivated fields in the cold weather, and there are other leguminous weeds which may or may not be valuable in pasture land. There are found growing naturally at Pusa at least four good grasses. *Dubh* (Cynodon Dactylon), *Apang* (Andropogon annulatus), *Suir* (Paspalum Royleanum) and *Jobh* (Ophiurus sp.).

CATTLE MANURE.

By D. CLOUSTON, M.A., B.SC.,

Deputy Director of Agriculture, Central Provinces.

It is a recognized principle in manuring that the composition of the manure should be regulated by (1) the deficiencies of the soil, and (2) the particular requirements of the crop. The poverty of a soil is nearly always due to a lack of one or more of the three most essential plant foods, nitrogen, phosphoric acid and potash. Black cotton soil is especially deficient in nitrogen.

One of the more important problems investigated at the Nagpur Experimental Farm in the Central Provinces deals with the most profitable nitrogenous manure for a cereal crop on black cotton soil. Such manures may be roughly divided into two classes :—(1) bulky manures, such as cattle-dung ; and (2) artificial manures, such as saltpetre. These two are taken as examples, because they are locally obtainable and are representatives, the first of slow-acting manures, the second of quick-acting chemical manures.

In western countries farm yard manure is considered the chief available manure. This indispensable and time-honoured product of the farm was never valued in Europe and America more highly than at the present day. Artificial fertilizers have come more and more into use as cultivation has become more intensive, but the farmers of the West use them only to supple-

ment, not to replace natural manure. In cattle manure, intelligent farmers in any country should recognize a cheap product of the farm that is always available in arable cultivation, which will produce good crops, gradually enrich the soil and improve its physical texture.

In the Central Provinces and Berar, much of the cattle-dung is only used as fuel. In some districts even that part of it which, in the rainy season, cannot be dried for fuel, is thrown out as so much rubbish, or sold at a mere nominal figure to the more enterprising cultivators. The price in Raipur is two to four annas per cart-load; in other districts it seldom exceeds four annas. The wastage of manure in India has generally been discussed by Scientific Agriculturists in a compromising spirit. Excuses for the cultivator were freely offered. One apologist expressed the opinion that the ashes of the dung and the supposed large amount of nitrogen obtained in the rainfall as nitric acid together make up for the loss that the dung suffers in burning. Another writer recognized the great difficulty experienced by the cultivators in obtaining other fuel, and suggested that the black cotton soil of the Central Provinces is productive enough without manure. Such theories are only true in part. Careful investigation and fuller knowledge of local conditions have shown that there is error in both. It has long since been proved that in the process of burning, over 97 per cent. of the nitrogen of cattle-dung is dissipated, and that the manurial value of the ash is much less than that of the dung from which it was derived. It has been proved too, that the rain of tropical countries in general does not supply the soil with a greater amount of nitrogen than the rain of temperate climates, the average total for tropical countries being only 3·54 lbs. per acre annually. It is fairly certain that the fertility of the black soils in the Central Provinces will continue to decline, unless cattle-dung is more generously used as manure. Other sources of fuel supply would be better exploited, if the valuable properties of well-made cattle manure were fully recognized. The results per acre obtained at the Nagpur Farm by the use of saltpetre, cattle-dung and the ashes of cattle-dung

as manures for irrigated and dry wheat respectively are given below :—

Irrigated Series.

Manure Applied.	Average in lbs. of Grain.				Average increase due to Manure.		Water rate and cost of Manure.	Profit (+). Loss (−).
	5 years 1890—94.	5 years 1895—00.	5 years 1901—06.	15 years 1890—06	Lbs. of grains.	Value of increase.		
						Rs. a. p.	Rs. a. p.	Rs. a. p.
Saltpetre 240 lbs. ...	931	826	1,278	1,012	517	19 14 0	18 10 0	+ 1 4 0
Cattle-dung 160 mds. ...	717	915	1,500	1,044	549	21 2 0	8 0 0	+13 2 0
Ashes of 160 mds. of cattle-dung ...	584	618	820	677	182	7 0 0	8 0 0	− 1 0 0
No manure ...	486	371	627	495	...	...	2 0 0	...

Unirrigated Series.

Manure Applied.	Average in lbs. of Grain.					Average increase due to Manure.		Cost of Manure.	Profit (+). Loss (−).
	5 years 1885—90.	5 years 1890—95.	5 years 1895—01.	5 years 1901—06.	20 years 1885—06.	Lbs. of grain.	Value of increase.		
							Rs. a. p.	Rs. a. p.	Rs. a. p.
Saltpetre 240 lbs. ...	1,133	751	514	817	803	323	12 7 0	16 10 0	−4 3 0
Cattle-dung 160 mds. ...	913	627	365	1,012	729	249	9 9 0	6 0 0	+3 9 0
Ashes of 160 mds. of cattle-dung ...	949	576	359	724	652	172	6 9 0	6 0 0	+0 9 0
No manure ...	799	418	197	507	480	...	...	...	...

The first statement shows that cattle-dung for irrigated wheat is more profitable than saltpetre and has greater residual effect. The manurial value of the ashes of cattle-dung is shown to be considerable in comparison with no manure. The ashes appear to be almost exactly equal in value to ⅓rd the dung from which they were derived. Two-thirds of the value of cattle-dung are therefore lost when it is used as fuel. This means a loss of Rs. 14 per 160 maunds. It is very questionable whether the fuel cakes made from this quantity of dung would be worth this sum. In the second statement the dry crop results are irregular. The explanation is that without irrigation the effect of season is often greater in determining rabi outturn than the effect of manure. Without

water bulky and slow-acting manures lose, to a great extent, their effectiveness ; for though the plant food is there, it cannot be taken up by the crop save in a state of solution in water. The bulky manure when applied to dry land may even do harm by attracting white-ants which cause much damage in the Central Provinces. In seasons of favourable rainfall, the superiority of cattle manure over saltpetre for dry crop wheat has been amply proved on the Nagpur Farm. Percentage increases of wheat from comparative irrigated plots in dry and wet seasons are shown below. The plots were irrigated twice each year and manured as shown in the statement :—

Manure per acre.	Percentage increase.	
	For seven dry years.	For eight wet years.
Saltpetre 240 lbs.	114% ×	97% ×
Cattle-dung 160 maunds	126%	95%
Unmanured	......	......

If full advantage is to be taken of cattle-dung as a manure for unirrigated land, it should always be applied to *kharif* crops. Where *kharif* crops are the only ones grown, or where they are included in the rotation in vogue, this can be done. The rotations practised in the Central Provinces and Berar nearly always include a *kharif* crop, so that there would be no difficulty in applying the manure at the beginning of the rains. By the combined effect of the rains and tillage operations the manure is thoroughly incorporated into the soil, and full advantage is taken of it by the *kharif* crop grown: the residue is very beneficial for the *rabi* crop that follows on the same soil. The most profitable results will be obtained from the use of cattle-dung if it be applied to the same soil only after intervals of two or three years. An experiment with cotton and *Juar-Tur* grown as a two-years' rotation at the Nagpur Farm has so far given results which tend to prove this. The plots were manured in the

year in which cotton was grown. The outturns are given in lbs. per acre :—

MANURE.	1902-03.			1903-04.			1904-05.			1905-06.		
	Crop.	Lint.	Seed.	Crop.	Grain.	Fodder.	Crop.	Lint.	Seed.	Crop.	Grain.	Fodder.
Saltpetre (40 lbs. N. per acre)	Cotton	386	650	Juar	770	2,075	Cotton	255	570	Juar	690	2,311
				Tur..	250	445				Tur..	125	200
Cattle-dung (40 lbs. N. per acre)	,,	430	769	Juar	955	2,625	,,	350	715	Juar	901	3,560
				Tur..	440	855				Tur..	235	280
Unmanured ...	,,	235	419	Juar	590	2,080	,,	150	295	Juar	719	2,448
				Tur..	355	755				Tur..	200	276

If owing to particular agricultural conditions *rabi* crops are the principal ones grown, as in parts of the Nurbudda Division in the north of these Provinces, where wheat, gram, til and linseed are the staple crops, the question naturally arises how this manure can be most profitably applied under these conditions. This question has also been investigated, and it has been found that for unirrigated *rabi* crops June is the best time, but for irrigated *rabi* crops the applications made in August give better results.

The black cotton soil of the Central Provinces must have deteriorated in fertility. It has received deficient supplies of manure for centuries. It has stood the strain well, but can only be renovated by judicious applications of well-rotted cattle manure. The problem to be solved is how far the present supply can be made to meet requirements. The number of dung-producing animals being known and also the area under crop, the amount of manure available per acre can be found. In the Central Provinces and Berar there are 10,661,042 cattle, including buffaloes. On an average each one of these will produce $2\frac{1}{2}$ tons (70 maunds) of dung annually, this being the weight at the time of application. In an experiment tried this year at the Nagpur Farm, a working bullock was found to give 3·6 tons or 101 maunds annually, when the stall droppings and the very small quantity of litter used were collected. At Cawnpore a mixed herd of cows and young animals were found to yield at the rate of

$2\frac{1}{2}$ tons annually. The ryot should, therefore, have at least $2\frac{1}{2}$ tons of cattle manure per head of stock every year. The 10,661,042 cattle of the Provinces should therefore give annually 26,652,605 tons of well-rotted dung, which would be sufficient to manure the whole area under cultivation at the rate of $3\frac{1}{5}$ tons once in three years. If this were universally carried out by the cultivators, it may be safely stated that their net farming profits would be enormously increased, even though some expenditure had to be made in the purchase of wood for fuel.

The total amount of manure available could be very much increased if steps were taken to utilize the dung of horses, sheep and goats, night-soil, leaves, crop-refuse, road-scrapings, animal urine and all other decomposing and putrescible material that is always obtainable on a farm. Even then the cultivator would find the supply inadequate to meet the requirements of intensive cultivation, but, in the near future, it is hoped that the present market prices of artificial fertilizers will be reduced to a price at which he can profitably utilize them. A light manuring with cattle-dung, supplemented by a small amount of a quick-acting nitrogenous fertilizer, would suit the requirements of black cotton soil—the one to renovate a soil depleted of its source of nitrogen, *viz.*, humus, the other to give the crop a good start in its early stage.

Analyses of fresh Indian cattle-dung show that it is normally rich in nitrogen. Rotted Indian cattle manure contains a comparatively low percentage of moisture often not more than 35 per cent., while that made in Great Britain generally contains 70—75 per cent., and for that reason the percentage of nitrogen is very much higher in the former than in the latter. Samples from the Nagpur Farm generally show from 1 to 1·3 per cent. of nitrogen, which is double the amount found in ordinary English cattle manure. That which is commonly made by the ryot of these Provinces, however, is of the poorest description owing to the faulty methods of conservation practised.

The value of cattle manure depends (1) on the kind of animals producing it; (2) the quality of the food they consume;

and (3) the method of conservation. The quantity of nitrogen, potash and phosphoric acid voided in the manure of adult animals that are neither gaining nor decreasing in weight will be nearly the same as that contained in the food consumed. The manure from working bullocks should therefore be rich. The manure from growing animals that are converting part of the albuminoids and ash constituents of their food into animal tissue is poorer, as is also that of cows that are supplying milk or that are in calf. Forty per cent. of the cattle of these provinces are of the former class, that is to say, they are adult working animals that retain little, if any, of the nitrogenous or ash constituents of their food in their bodies.

When a large amount of concentrated food, rich in nitrogen, is consumed by the cattle on the farm, it follows that their solid and liquid excrements are proportionately rich in nitrogen. In the Central Provinces and Berar, a very considerable quantity of cotton seed, linseed and other highly nitrogenous foodstuffs are consumed on the farms, being given chiefly to the working bullocks, so that the nitrogen of the food should almost all reach the soil again in the manure.

The method of storing cattle-dung in these Provinces is a very primitive one. That part of it which is to be kept for manure is ordinarily thrown together in loose heaps at some distance outside the village. No account is taken of the evanescent nature of its most useful constituents, of the ammonia which passes off into the air, or of its salts of nitrogen, potash and phosphoric acid which are leached out of it by the rains; consequently only the more stable and insoluble part of it ever reaches the cultivator's field. The following three principles should be adhered to in its conservation :—(1) The urine as well as the more solid excreta should be preserved; (2) the manure should be stored in pits and always kept moist, but should never be allowed to get over-soaked; (3) the manure should be well-rotted before it is applied to the land.

The two systems of conservation of urine which appear to be most suitable for the agricultural conditions of these

provinces are what may be called the open-drain and dry-earth systems. The former is now being carried out at the Experimental Farms. The cattle-shed is provided with a stone floor and a 'V'-shaped gutter, one foot wide and four inches deep. The floor has a gentle slope so as to carry the urine down to the gutter, which in turn carries it the whole length of the stalls to a masonry pit outside the shed. This pit is provided with a concrete floor to prevent the loss of liquid manure by drainage. As much litter as is available is made use of. The floors of the stalls are kept swept and clean by washing them down daily. The urine, supplemented by the added water keeps the manure moist at all seasons. A roof is erected over the manure pit to protect the manure from the scorching sun and drenching rains. This method of conserving manure should meet the approval of the landowners, who cultivate their own fields and who can afford the initial cost of making the stone floor, gutter and pit.

The dry-earth system is the one which is most likely to be adopted by the poor ryots, as it is a simple method which involves no initial expenditure and requires no other bedding than the dry earth used. Like the open-drain system, it is based on sound scientific principles. Dry earth is spread in the stalls to a depth of six inches, and is kept in position by a plank of wood of the same depth, supported by bamboo pegs. The earth absorbs the urine and retains its most valuable ingredients. After three or four weeks the urine-earth is conveyed to the pit and a fresh supply added to the stalls.

By removing the excreta daily the stalls are kept clean. Should the earth get baked, the surface is slightly scarified by means of a rake, so as to make it pervious to the liquid manure. The earthen pit, in which the dry excreta and urine-earth are stored, is protected by a roof of thatch. An open drain carries off the water that falls from this roof. If the manure gets too dry, certain holes in the roof are uncovered and some rain-water admitted thereby. In the dry season the manure should be kept moist by hand-watering.

A manure pit should not exceed five feet in depth. Its cubic content will depend on the number and size of the farm stock. One cubic yard of dung in India weighs about half a ton, and a pit for a mixed herd should, therefore, provide for five cubic yards per head. On the Government Farms, where working bullocks only are kept, six cubic yards or what is sufficient to hold three tons of manure per animal is provided for. The pit should be in close proximity to the shed, and provided with an open drain to prevent surface water from flowing into it.

It can be claimed for these two systems of conserving manure that by them both the solid and liquid excrements are saved. The urine or liquid excrement contains the greater part of the most valuable constituent, nitrogen. The nitrogen of the urine is, moreover, in a very soluble form; its effect on a crop is to give it a good start, while the more durable but less soluble solid excreta gives out its plant food slowly. Being stored under shelter and kept moist, fermentation is quick and thorough, especially when the urine is allowed to run into the pit as by the open-drain system. At the end of the year, rich, well-decomposed manure is obtained, which in a very short time becomes thoroughly intermixed with the soil to which it is applied. Such manure is complete in itself, and is specially suited for the black cotton soil of the Central Provinces and Berar.

Cattle manure made in this way is what is wanted to renovate soils impoverished by the methods of farming that have been followed in these Provinces for many centuries.

THE PREVENTION OF FODDER FAMINES IN THE CHITALDRUG DISTRICT IN MYSORE.

By B. RAMASWAMI IYER, B.A.,

District Forest Officer, Chitaldrug, Mysore.

Chitaldrug is the most arid district of the Mysore State, its geographical position being such that it does not receive the full benefit of either the south-west or receding monsoon. Past history shows that on an average every third year gives a poor harvest, accompanied by scarcity of fodder and water. About once in three years the district is blessed with a bountiful harvest and then the grass and grazing is much in excess of immediate requirements. The district should be always prepared for a scant year. The following measures for the safe storage of fodder, are suggested with a view to prevent serious loss of cattle in seasons of drought.

In years of plenty, every ryot should contribute in proportion to the size of his holding a certain quantity of hay to a village communal stack. This quantity should be sufficient to carry his cattle through customary periods of drought, making an allowance of 10 lbs. per day for each animal. This hay should be securely stored in stacks near the village. The stack yard should be fenced. Each hay stack should be built on a platform of brush-wood or such like material, so that dampness is prevented from rising from the soil and loss from white ants minimized. The stacks should be properly built by experienced cultivators and properly thatched, otherwise much loss will be caused by rain. The safe custody of the stacks should be entrusted to the village watchman under the control of the Village Council (*Punchayat*). The headman (*Patel*) should keep a regular account of the grass

contributed by each individual and of out-goings. These accounts should be checked at the annual examination of the village records (*Jamábandi*). The stored hay should not be touched until a year of fodder scarcity is declared by the Deputy Commissioner, when under the supervision of the Amildar each ryot should receive the quantity contributed by him. In the unlikely case of the stock accumulating in excess of possible requirements, the surplus should be sold for the benefit of those concerned. The practical working difficulties will certainly not be greater than the somewhat analogous plan of Village Co-operative Credit Societies.

The communal grazing lands, assigned to villages in this district, are extensive, but the ryots do not concern themselves with their improvement. Cattle usually graze over the whole area throughout the year, with many harmful results. Grazing is allowed early in the rains, so that the sprouting grass has no chance to grow properly. Clay soil is, during heavy rains, injuriously trampled, and lighter soil is so broken up that much of it is carried away into the neighbouring tanks or elsewhere. This erosion is increased by the removal of trees and shrubs. Even the stumps and roots are dug out for making charcoal. In consequence, these pasture lands are generally deteriorating. This deterioration of pasture lands is most evident near the larger villages. It is desirable to check this deterioration and to arrange for communal conservancy in a practical way.

The grass land of each village should be equally divided into two blocks. Each block should be ordinarily open each year alternately for grazing and for grass-cutting. The portion reserved for hay will afford a certain amount of grazing in the fair season from January to July.

The State Forests of Chitaldrug district yield in many places considerable quantities of grass fit for making superior hay. Such portions of the forests should be utilized as 'Forest Fodder Farms.' They should be protected from unauthorized grazing, if necessary, by fencing or otherwise. The grass should be cut in the months of November and December, and stored securely in

stacks. In order to arrive at definite conclusions regarding the probable advantages of storing hay, a beginning should be made on an experimental scale and the work should be extended as experience may direct. Experience might show that baled hay could be more economically preserved from year to year than grass stacked in the ordinary way.

Trees which once existed on village grass lands have disappeared or are fast disappearing in consequence of heavy lopping. The destruction will soon be complete owing to increasing population and cultivation. Useful trees should be planted and protected, as they are essential to preserve moisture in the soil, protect the grass, offer shelter to cattle against sun and rain, and provide fruit for man, also leaf fodder for sheep and goats.

The people of the Chitaldrug district are chiefly agriculturists. Seasons of distress are of frequent occurrence. It is, therefore, imperative to prevent, if possible, fodder famines on the lines above suggested.

THE CULTIVATION OF PARA RUBBER IN NORTH-EAST INDIA.

By Dr. H. H. Mann, D.Sc.,

Scientific Officer to the Indian Tea Association.

Numerous attempts have been made both on the Government Rubber Plantation at Tezpur, Assam, and by Tea Planters in several districts of the Assam Valley, during the past few years, to grow the *Para* rubber (*Hevea brasiliensis*), the culture of which has been such a success in Ceylon and in the Malay States. The results were unsuccessful. Some of the experiments are still being continued, but there is little confidence in the ultimate establishment of a *Para* rubber industry in the Brahmaputra Valley.

Of course these results are not necessarily applicable to other parts of North-East India, and in fact, evidence is to hand that in the upper part of the Valley of the Surma and its tributaries—in other words, in Cachar,—*Para* rubber can be successfully cultivated, that during its early stages it grows nearly as fast as in Ceylon, and that after ten years or so it produces rubber which compares in point of quality and yield with that in other districts recognized as favourable for the purpose.

These remarks are made as the result of the tapping of some ten trees which were planted in the Dhulai Tea Estate, Hailakandi, Cachar, in 1897, and which have grown without special attention among the tea ever since. They are healthy, and their size can be judged by the following figures for the

girth, three feet from the ground, at the end of 1905 and 1906 respectively :—

Number of Tree.	Number of Trunks.	1905.	1906.
1	2	1′ 10½″ & 1′ 7½″	2′ 1″ & 1′ 10″
2	1	2′ 9″	2′ 9″
3	1	2′ 9″	2′ 8″
4	1	1′ 10″	2′ 2″
5	1	2′ 4″	2′ 8″
6	2	2′ 2½″ & 1′ 8″	2′ 5″ & 2′ 0″
7	2	1′ 3″ & 2′ 0″	1′ 6″ & 2′ 2″
8	2	1′ 9″ & 1′ 6″	2′ 2″ & 1′ 7″
9	1	1′ 10″	2′ 2½″
10	1	2′ 5½″	3′

During the season 1906-07, these ten trees were all tapped, either by the complete spiral or the herring-bone system, with the Bowman-Northway tapping knife, and alternate use of the spurwheel. Rubber was freely yielded by all the trees, and the total amount obtained was ten pounds of dry rubber or one pound per tree. They were under tapping from December to March, when the quantity of rubber obtained became too small to make it worth while continuing. On re-opening the cuts early in April, however, rubber again ran fairly freely. These figures, of course, give no evidence as to how much rubber could have been obtained earlier in the plant's life, say, at six or seven years old when trees in Ceylon are ready to tap, but they do indicate that in South Cachar on rich flat but well-drained land there is no difficulty in growing *Para* rubber and getting a fair yield from it.

The trees were healthy, were flowering vigorously and produced seed.

I am indebted for these figures and notes to Mr. W. Stiefelhagen, the Manager of the Tea Garden, in which the trees are planted.

Several planters in the same district have recently planted *Para* rubber on land recently cleared. The young trees are so far quite healthy where the position is sheltered from the sun in the hottest part of the day. I am permitted by Mr. W. K.

Green, the Manager of the West Jalinga Tea Estate, to quote the following figures to show the growth of the young plants :—

(1) *Rubber stumps received from Ceylon and planted in April* 1905. (Average of sixteen plants).

Date.	Height.			Girth 1 foot from Ground.			Girth 3 feet from Ground.		
	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.
	Feet.	Feet.	Feet.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Nov. 28, 1905 ...	3·4	5·4	1·4	1·6	2·0	0·4	...	...	...
Sep. 30, 1906 ...	10·0	13·0	5·7	3·7	5·6	2·5	2·5	3·5	1·5
April 23, 1907 ...	11·9	14·5	7·0	4·6	6·0	3·2	3·4	4·5	2·0

(2) *Rubber seeds received September* 1904 ; *trees planted July* 1905. (Average of sixteen plants).

Date.	Height.			Girth 1 foot from Ground.			Girth 3 feet from Ground.		
	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.
	Feet.	Feet.	Feet.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Nov. 24, 1905 ...	3·8	5·3	2·2	2·0	2·5	0·6	...	...	...
Sep. 30, 1906 ...	10·0	12·2	6·3	3·7	4·6	2·7	3·2	3·6	2·1
April 23, 1907 ...	13·0	14·0	9·5	5·6	8·0	4·5	4·3	6·0	3·5

(The figures for April 23rd, 1907, are only for eleven plants, as the others had been damaged by deer, and the figures for three feet above the ground are only for those with single stems.)

(3) *Rubber seeds received September* 1905 ; *trees planted June—July* 1906. (Average of twenty plants).

Date.	Height.			Girth 1 foot from Ground.			Girth 3 feet from Ground.		
	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.
	Feet.	Feet.	Feet.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Apl. 23, 1907 ...	5·5	7·0	4·0	2·2	2·7	1·5	1·7	2·5	1·5

The figures above tabulated indicate a possibility that *Para* rubber will probably succeed in Cachar. The figures are, however, only preliminary and much more information will have to be gathered before it can be definitely decided whether this district can compete with those districts in which rubber is already profitably established.

THE TAPPING OF ASSAM RUBBER (FICUS ELASTICA).

By Dr. H. H. MANN, D.Sc.,

Scientific Officer to the Indian Tea Association.

The methods hitherto in vogue in India for the tapping of Assam rubber have been extremely crude and wasteful of bark. The system used on the Government plantation at Tezpur (Assam) leads to a loss of four per cent. of the bark at each tapping, an amount which appears extraordinary when compared with that lost under the improved methods now employed in tapping other kinds of rubber trees in Ceylon and elsewhere. I am able now to describe a method which has been tried and used with success by Mr. W. Stiefelhagen in Cachar, and which leads to little loss of bark, and to rapid healing of the injuries caused by the tapping.

Instead of attacking the bark with a V-shaped gouge, as has been the custom at Tezpur, or with a scraping knife of any kind, Mr. Stiefelhagen employs an ordinary carpenter's chisel, ½-inch to ¾-inch wide, and drives this into the bark vertically in a series of cuts, each the width of the chisel, across the direction of the branch being tapped. At least half an inch must be left between each incision. The rows of incisions are made about six inches apart up the stems and large branches of the tree, and strips of tea lead are pinned to the stems underneath each row. in such a way that the latex running down into the channels thus made, drops into a cup fixed at the end of each channel of tea lead. By this means, tapping through the cold weather from November to March, about two-thirds of the latex finds its way into the cups, while one-third coagulates on the cuts.

It will be easily seen that the injury done to the tree by this method of tapping is very small indeed compared with that usually adopted. It is easy to apply, and a man becomes very expert in a few days. I, myself, tried to carry it out during a recent visit, and found there was no difficulty, after a little practice, in judging how far in to drive the chisel without materially injuring the cambium layer. The yields obtained were very good, as compared with those given on the Government plantation, and are set out below.

Eight trees, planted in 1882, were tapped in 1905-06 and gave an average of six pounds of rubber per tree, which, including all grades, obtained an average price of three shillings and ninepence per pound in London. The yield of each individual tree was not kept. In 1906-07 *the same* trees were tapped again, and gave (individual trees) as follows :—

Number of tree.	Weight of rubber.	Number of tree.	Weight of rubber.
	lbs.		lbs.
1.	10	5.	$5\frac{1}{2}$
2.	$3\frac{1}{4}$	6.	$4\frac{1}{2}$
3.	4	7.	4
4.	$6\frac{1}{8}$	8	$2\frac{1}{2}$

The average yield was therefore five pounds per tree, and the amount given by individual trees varied from 10lbs. to $2\frac{1}{2}$lbs. The cuts made in the previous year were healed and would hardly have been noticed.

Four younger trees were also tapped by the same method in 1905-06 and 1906-07. These were planted in 1889-90, and were hence sixteen and seventeen years old respectively in the two years. The yield was not carefully kept in 1905-06, but it amounted to about 2 pounds of rubber per tree. In 1906-07, the four trees gave respectively $2\frac{1}{4}$, $3\frac{1}{4}$, $1\frac{1}{4}$ and $2\frac{1}{2}$ pounds of rubber, or an average of $2\frac{1}{4}$ pounds per tree. These trees were apparently by no means exhausted, as on making a series of new incisions in one of them early in April 1907, the latex flowed very freely, and a considerable further yield could have been obtained.

It has usually been stated that Assam rubber trees can only be tapped once in two or even three years. Though the figures at present given are by no means sufficient, yet they suggest that this inability to bear frequent tapping may be due to the excessive injury to the bark caused by the older methods of carrying out the operation. Certainly there is no sign as yet of the trees now being considered materially losing yield through tapping in two successive seasons.

The individual trees vary enormously, as will be seen, in the amount of rubber which they give, and not only this but the latex is much more fluid and hence more easily worked from some trees than from others. Whether this is a peculiarity of the tree or due to slight variations in the conditions of growth is at present uncertain. In the meantime, it is wise to take all cuttings for new extensions of Assam rubber from the trees giving the best yield and the most fluid latex. It is curious to find that, in every case, more latex is given by the large branches of the trees than by the main stem.

The method of treatment of the rubber obtained is different from that adopted on the Government plantation. That which coagulates on the cuts, amounting to about one-third of the whole is, of course, the best and requires no further treatment. The remainder is mixed with a 2 per cent. solution of formalin, and poured into clean half bamboos (bamboos split longitudinally), laid parallel to one another, and the whole covered from the direct rays of the sun. Within a day the whole of the rubber is coagulated, and can be removed. The long strips are then allowed to dry before rolling together into balls. Many other materials have been tried instead of formalin for mixing with the latex, but none have answered the purpose so well, and given rubber equally free from stickiness.

I cannot think that this method of tapping and treating Assam rubber is by any means the final word on the subject. It is, however, a distinct step in advance on those hitherto in use in India, and would seem well worth following up by those who have the opportunity of doing so.

THE FOOD OF THE MYNAH.

By C. W. MASON,

Supernumerary Entomologist, Pusa.

As in England so many birds prove invaluable to the farmer, so in India we may expect birds to be equally invaluable to the Indian agriculturist. That some birds eat insects, and among them some of the worst pests, is a matter of everyday observation; but it is not known definitely what birds eat what insects; investigations are being carried out at Pusa with regard to this point, both from field observations, and from an examination of the food in the birds, the results of which should prove of great interest and value.

This note deals with the mynah (*Acridotheres tristis*). The mynah's food is very varied, consisting of fruits, seeds and insects. It is partial to the common wild figs, and with them devours the fig parasite and its parasite. The large fleshy flowers of the tree cotton are largely eaten. Of seeds, grass forms by far the greatest bulk, but wild hemp is also largely eaten. Its insect food is very varied, in fact the mynah would seem almost a general insect feeder; but some of the commonest insects, no doubt being distasteful or protected by scent, are not touched by the mynah.

The mynah has one point in common with other birds, namely, an individual preference on the part of each bird for certain forms of insect food. With the Mynah on several occasions, as also with the Hoopoo (*Upupa indica*) and the common Hawk-Cuckoo (*Hierococcyx varius*), I have found, of two or three birds shot feeding together, that one contained completely different food to any of the others. These birds had been

observed together, and feeding for some little time. In each case with the individual mynah, its food consisted wholly of Surface caterpillars (*Noctuid larvæ*), and no sign or trace of other food. It seems that if a bird eats these caterpillars, they form the whole, or very nearly so, of its food.

From the list of insects given below, it would seem that the mynah does most insect hunting on the ground : nearly all the insects in the list occur on the ground, among grass and weeds as well as in the crops, much more than on trees.

The following are the lists of insects found in the mynah :—

I. ACRIDIIDÆ. (Grasshoppers.)
   1. *Chrotogonus*, several species.
   2. *Oedaleus*, several species.
   3. *Tryxalis*, several species.

II. FORMICIDÆ. (Ants.)
   1. *Camponotus compressus.*
   2. *Mymecocystus setipes.*
   3. An unidentified species.

III. CURCULIONIDÆ. (Weevils.)
   1. *Myllocerus maculosus*, the white weevil.
   2. *Paramecops* sp.
   And two unidentified.

IV. OTHER COLEOPTERA.
   1. Various elytra only. (Not identified.)

V. LEPIDOPTERA.
   1. Noctuid larvæ, Surface caterpillars.
   2. Noctuid moths, too damaged to identify.

Probably all insects in the above orders and families would be taken, provided they were not too large, or had danger colours, and could be got at. Spiders are largely eaten.

The mynah has not been found to damage any crops at Pusa from January to May. Only three wheat grains have been found in the numbers of birds examined. It was reported to have damaged Juar (Sorghum) last December.

The mynah much resembles the English starling in habits, it works arable and grass-land in the same way, though not so methodically. It commonly occurs in flocks up to 60 or 80, sometimes more, but usually about 10 or 20 are seen together.

Nesting occurs in holes in trees, sometimes on the branches and in holes in walls and thatched roofs. The young are fed largely on various lepidopterous larvæ, more so than on any other food. If in any district the mynah was causing damage so as to be regarded a nuisance, the young should be destroyed just before they can fly; they are fed on insects (larvæ), and so up to that time are doing good rather than harm, as is the case with the English house sparrow.

If mynahs are damaging small plots of crops only, they can be scared off easily.

We should be very glad of assistance in this enquiry from observers of birds in India; collectors of bird skins could especially render great help, as a correct identification of the birds is as essential as a correct identification of the insects upon which they feed. We shall be glad to identify the crop contents and gizzard contents sent in to Pusa as far as possible. It is proposed to identify the insect food of all birds, rare or common, not only those found in or round crops, but also exclusively jungle birds. Birds living entirely in the jungle may prove as valuable as those on arable and grass-land, feeding on the insect pests of crops after migration to jungle plants. We can keep a certain check on insects on the crops, but when these insects continually come in from the jungle, the value of the check is partially lost, and to attack a pest when migrated to the jungle would seem hopeless. In this respect jungle birds may prove of great value.

On application being made to Pusa, tubes, etc., for keeping and sending in the food contents (or crops and gizzards) to us, will be supplied with full directions.

THE PESTS OF INTRODUCED COTTONS.

By H. M. LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist, Agricultural Research Institute, Pusa.

Exotic cottons grown in India are liable, at first, to suffer to an abnormal extent from insect pests; when acclimatized, they suffer less; special precautions are always necessary. This note deals only with the pests which are likely to prevent the establishment and acclimatization of exotic varieties and of indigenous varieties transferred for experimental purposes from one district of India to another.

The Cotton Leaf Hopper is the worst pest. This small green insect sucks the juice of the leaves by cutting through the outer membranes. This attack on the leaf tissues probably gives entrance to diseased conditions which cause curling and withering of the leaves. There is no easy remedy against the leaf hopper. In the first stages of attack, the insect should be checked by liberal spraying with Crude Oil Emulsion,* a strength of 1 in 50 of water should be used.

Cotton Aphis.—Weak cottons are particularly affected by the cotton aphis; as a rule, the natural enemies of this pest keep it in check, but it is often advisable to spray with Crude Oil Emulsion diluted as above described.

Boll-worms attack all cottons. In Sind and the Punjab Egyptian and American varieties have under ordinary seasonal conditions suffered more than local kinds.

Bhindi (*Hibiscus esculentus*) is a good trap crop where it can be successfully grown near to or among cotton, provided the

* For formulæ of this see Leaflet on Crude Oil Emulsion and also "Indian Insect Pests."

green pods are regularly removed. Boll-worm often seriously affects the cotton bolls which first form. Such, when seen to be affected, should be removed and burnt. This will materially check the spread of the pest.

The Leaf Roller is the only other pest which specially attacks exotic cottons. The attack is limited to a short season and begins in the three weeks which follow the commencement of the rains. It can be easily seen by the rolled leaves and can be checked by hand-picking and burning if the work is thoroughly done.

Stem-Borer.—Two special pests attack perennial Tree Cottons. The stem-borer is a small weevil whose grub bores to the base of the stem and causes a characteristic swelling there. At Pusa, a reliable preventive was found in growing annual indigenous cotton, such as Broach Deshi, between the rows of the perennial varieties. The Deshi plants were pulled up and burnt as soon as they were seen to be affected. The stem-borer is only known to occur in Behar and Madras, but may appear anywhere.

The other special pest of Perennial Cottons is common in South India and Bombay. It is a weevil whose grub bores down the twigs and small branches. The withered branches are easily seen, and the only remedy is to cut these out periodically and burn them.

To prevent recurring damage to tree and annual cottons by insect pests, it is desirable to adopt the following general precautions :—

(*a*) Perennial cottons should be rested from vegetative activity for several months during the hot weather each year. The trees or bushes should be pruned at this time, and all decayed branches, leaves and bolls should be removed and burnt ; finally, the whole soil between the trees should be hand-dug or otherwise freely opened up by careful cultivation in the hot weather.

(*b*) Annual cottons should be grown in rotation and should not occupy the same land oftener than every second year. The plants cease to produce some time in the cold weather or at

latest at the beginning of the hot weather. As soon as gathering is completed and, especially, if the crop has been much affected with boll-worm and other pests, the stalks and all litter on the soil surface should be gathered and burnt.

(*c*) Flower buds and bolls, which appear in annual or perennial cottons at the wrong season and worthless bolls produced in the regular season, should be removed and burnt. Such serve to provide food for injurious insects during certain stages of their history. It is most desirable to deprive injurious insects of their ordinary food for defined periods.

(*d*) When cotton is introduced into a new locality the introduced seed should be fumigated.

(*e*) If a pest appears in a locality and multiplies abundantly, its parasite should be introduced. By this means serious damage by boll-worm in the Punjab has been greatly reduced. The work has recently been extended to Sind. Similar work can be further extended by communicating with the Imperial Entomologist.

NOTES.

Sericulture in Kashmir, Baluchistan and Quetta.—The Silk Association of Great Britain and Ireland, in Report No. 22, 1906, briefly refers to Sericulture in Kashmir, Baluchistan and Quetta. The more salient points are noted below.

The raw silk produced in Kashmir in 1905 yielded a profit of £28,139 or $58\frac{1}{2}\%$ on invested capital. In 1906 a record crop of cocoons was produced, and with advanced prices it is expected that the profits will exceed those of the previous year. Kashmir raw silk chiefly $\frac{9}{11}$ deniers meets with a very ready sale at Lyons. The extension of mulberry cultivation is carefully attended to by the State. The number of rearers in Kashmir is yearly increasing. This successful industry now gives employment to nearly 70,000 persons.

Major H. L. Showers, C.I.E., Political Agent in Kalat, commenced experiments in Sericulture in the Mastung Valley in Baluchistan, obtaining some silkworm-eggs from the Kashmir Durbar and also from the South of France. These experiments have given satisfactory results. Expert opinion on the raw silk was favourable. This silk was sold in London at 13*s.* 3*d.* and 13*s.* 4*d.* per lb. The Mastung Valley is the home of the mulberry and the local tribesmen have been quick to see the advantages of cocoon-rearing. The silk industry promises, therefore, to get a permanent footing in Baluchistan.

Some silkworm-eggs were supplied by the Kashmir Durbar for experiments in Quetta. The cocoons obtained from these eggs were reeled in Kashmir filatures. The raw silk and a sample of piece goods woven from this silk were found to be of excellent quality.

It is probable that Sericulture will be arranged for in the Punjab on the lines pursued in Kashmir and Baluchistan.—(EDITOR.)

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AN EXPERIMENT IN ASSAM TO PREVENT BY MEANS OF CRUDE OIL EMULSION THE INJURIOUS EFFECTS OF PARASITES ON WORK CATTLE.—Mr. D. L. Stewart, the Manager of the Assam Zemindary Company, imported work cattle from Tirhoot in November last. The necessity for this importation arose because the local breed does not supply the present local demands and because the opening up of the Assam Valley for the cultivation of rice, other cereals, jute, etc., will require a large importation of work cattle. These can be bought advantageously in Tirhoot. Even with the added transport charges they are cheaper than local Assam cattle because they are stronger and are capable of doing much more work.

The cattle imported by Mr. Stewart became infested with biting flies, lice, ticks, bugs and leeches by grazing in the harvested paddy fields and grass jungles or from the litter which was necessarily used in the stables. The bullocks lost condition rapidly and were mere wrecks in a month.

Mr. H. Maxwell-Lefroy, Imperial Entomologist, on being consulted, suggested washing or spraying the cattle with Crude Oil Emulsion. This was done and was found to be a complete success. The leeches did not attach themselves to the cattle whilst at pasture except occasionally inside the nostrils. Flies did not settle on the cattle—the ticks and bugs fell off dead. Lice and fleas were more difficult to deal with. They had to be brushed out when the coat dried after spraying. A broom-corn brush, commonly called a "dandy" brush and ordinarily in use for grooming horses, was found most useful. The spraying and grooming to be quite effective had to be repeated once a week. The effect on the skin and hair of the cattle has been excellent.

Leeches affect local cattle as well as the imported cattle and have to be picked off every evening when the cattle return from

grazing. Mr. Stewart tested the effect of Crude Oil Emulsion diluted to the ordinary strength on leeches by applying a sprinkling to a number which were purposely collected. They died at once.

Mr. Stewart says that work cattle in Assam, both imported and indigenous, suffer greatly from sores, the irritating cause being particular flies. The sores are situated beneath the side of the hump and above the point of the shoulder blade. Doubtless, the action of the neck yoke at work, aggravated by the persistent attentions of these flies, keeps the sores open until they eventually become hard lumps with deep sore cracks. Mr. Stewart found that the sores were effectively cured by softening with vaseline and washing out with diluted Crude Oil Emulsion applied rather more frequently than was necessary for the rest of the body. The sores soon healed up naturally chiefly because the flies were kept away. Mr. Stewart thinks that this treatment would be of great advantage to the ordinary Assam cultivator if brought to his notice and placed within his reach and also for the bullocks, some of them with ghastly sores, which work on the transport service, such as from Gauhati to Shillong.

Mr. Stewart further says that the cheapest and most economical way to spray an animal is to use a stiff brush or broom made of thatching grass. The stalks should be so tied in a bundle that the blades or leaves of the grass all lie evenly together. The blades should now be doubled back over the stalks and bound with the stalks for a length of six inches to form the handle of the broom. The blades should then be cut through at a point where they were doubled back. This gives a small broom with six inches of handle and six or eight inches of stiff brush. It has been found very effective in shaking the emulsion all over the animal. After sprinkling, the coat should be well rubbed, in every part with a wisp of straw.

One-half pint of Crude Oil Emulsion rubbed up in a kerosine oil tin of water gives the correct strength of mixture.

Fairly large bullocks at Pusa were found to require each approximately the following amounts according to the method :

Mr. Stewart's grass brush	... 1 pint
A sprayer	... $1\frac{3}{4}$
Rubbed with a cloth	... $1\frac{1}{2}$

with Mr. Stewart's method, and at half a pint of emulsion per 4-gallon tin of water, a gallon drum of emulsion would make 320 gallons of mixture, enough for approximately 48 bullocks to be treated once a week for a year. The yearly cost for one bullock works out at about four annas, the drum of emulsion costing Rs. 6-8 in Calcutta, Rs. 9-8 in Bombay.—(EDITOR.)

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WELL-SINKING EXPERIMENTS IN BHAVANAGAR.—Experiments in boring wells on the Japanese system were commenced in 1905 in the Bhavanagar State, Kathiawar, Bombay Presidency. In all five trials borings were made with the assistance of a Japanese expert well-sinker who had his implements made locally. It was found that the boring implement stuck at a certain depth and could not be taken out. The depth reached in one case was 110 feet. The boring was abandoned in each trial before water was found. It is reported that failure was at least partly due to the difficulty of making the Japanese expert and the labourers understand each other. The total cost of the borings amounted to Rs. 5,516-10-11. The expenditure involved was therefore considerable, and probably better and cheaper results could have been obtained by ordinary boring appliances.—(EDITOR.)

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PRELIMINARY EXPERIMENTS WITH JUTE IN THE MADRAS PRESIDENCY.—In accordance with the recommendations of the Board of Agriculture, experiments with Bengal jute (Corchorus) were made during 1905 at the Samalkota Station in the Madras Presidency with a view to test the suitability of the Godavari Delta for the crop. This first trial was not successful. As the result of experience, better arrangements for another trial were made in 1906. The results in 1906 were so encouraging that

more extensive experiments have been arranged for in the delta and other areas. The enquiry will form a definite feature in the Programme of work of the Madras Agricultural Department.

The fibre obtained from the jute averaged 7 feet in length and was valued by Messrs. Ralli Brothers, Calcutta, at Rs. 10-5-0 per maund of 80lbs. The value of outturn was Rs. 85 per acre. It is expected that much better yields will be obtained as the local officers gain experience in determining how far the Bengal methods of cultivation should be modified to suit local conditions in Madras.—(EDITOR.)

* * *

GROUNDNUT EXPERIMENTS AT THE CUTTACK EXPERIMENT STATION.—Leaflet No. 2 of 1907, published by the Bengal Department of Agriculture, describes the results of the experiments with groundnut (*Arachis hypogæa*) during the past two seasons at the Cuttack Experiment Station. It also describes the methods of cultivation, treatment of the crop, mode and time of harvesting, etc. The trials were made on poor sandy soil, which is unsuitable for most other crops. The results were satisfactory. The yield obtained was 20 maunds per acre in 1905 and 16 maunds in 1906. Aman paddy or jute land is not suitable for groundnut. The crop will grow well on friable sandy loam soils if cultivated and manured sufficiently.—(EDITOR.)

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CHLORIS VIRGATA AND CHLORIS GAYANA.—In 1904, the Director of the Botanic Gardens, Sydney, brought to the notice of the Government of India, some of the advantages of the variety of grass *Chloris virgata* sw., known as Rhodes grass, which had been introduced with success into New South Wales from South Africa. The grass was said to be suitable for cold soils with light rainfall. A small quantity of seed of this grass and of *Chloris Gayana* was obtained in 1906 from the Minister of Agriculture, Pietermaritzburg, Natal. Both kinds were tried at Pusa. The seed was sown early in September on land which was well prepared and in good condition. Each kind was allowed

to seed and was cut at the middle of November. Chloris virgata yielded 480lbs. of seed and 1,006lbs. of hay per acre, while the yield of Chloris Gayana was 1,452lbs. seed and 2,178lbs. hay. The plants stood respectively $2\frac{1}{2}$ft. and 2ft. high. [Seven species of Chloris are described in Prain's "Bengal Plants," and Chloris virgata is said to be found in most of the provinces.] The seed now in stock is intended for more extensive trials at Pusa and for distribution to a small extent in order that the economic value of these grasses for grazing and for hay may be more definitely determined under varying conditions of soil and climate, etc.—(E. SHEARER.)

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DESTRUCTION OF RATS BY RATIN.—The attention of several officers in the Department of Agriculture in India has recently been drawn to a preparation known as "Ratin" for the destruction of rats and mice. This preparation is made by the "Ratin" Company, Ltd., of Copenhagen. It is said to be of a bacterial nature and may be obtained in liquid or solid form. It is highly recommended by the German Minister of Agriculture. Special tests have been carried out in the bacteriological laboratories and on a number of farms, by the Chamber of Agriculture for the Province of Saxony. The results are reported to have been highly satisfactory. The substance is said to be quite harmless to domestic animals.

In view of the enormous damage which in some districts is periodically done by rats to Indian crops, this preparation is well worth a trial. It is understood that "Ratin" is being tested in the laboratory and in the field by the Civil Veterinary Department. The London Office of the Company is at 17, Gracechurch Street, E. C.—(C. BERGTHEIL.)

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SOIL INOCULATION FOR INDIGO.—Experiments on the inoculation of Behar soils with cultures of the indigo nodule bacteria prepared according to the method of Dr. Moore of the United States Department of Agriculture have shown that absolutely

no benefit is to be derived from the application. Both the Sumatrana and Java varieties of indigo were tested and a variety of methods of application tried, but in every case the result was *nil*. The explanation is clear that Behar soils are sufficiently well provided with the necessary organisms, and that these organisms are in as active a condition as can be obtained by artificial culture. —(C. BERGTHEIL.)

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AN INSECT ATTACKING THE GRAPE VINE.—One of the few known insect enemies of the grape in India is a small beetle (*Scelodonta strigicollis* Mots), of a dull nearly black colour with bright bronzy reflections. This beetle is familiar to grape-growers in Western and Southern India; it destroys the tender shoots and buds, working a considerable amount of havoc in the pruned vines. (Plate XXIX—Figs. 5 and 6, the latter the natural size). Mr. P. S. Kanetkar, Superintendent, Empress Gardens, Poona, has sent the following description of the method used by cultivators to check this pest. The figures are from his drawings, and we have added an enlarged figure of the beetle and its outline natural size:—

"Contrivance made by vine growers at Nasik to catch insects on grape vines."

"Dry sheaths of the plantain (Fig. 1) are torn into shreds and made into little bundles about 6 to 9 inches long. One end of the bundle is tied firm while the other is kept loose. It is thus made into the form of a tassel (Fig. 2). Such tassels are placed on the pruned ends (Fig. 3) of the vines in the evening as the buds begin to swell and shoot forth. The insects after roaming about by day find a snug resort during the cold nights in these tassels (Fig. 4). In the morning, however, they find themselves in a bag or basket being shaken into it from their resort by the cultivator."—(H. M. LEFROY.)

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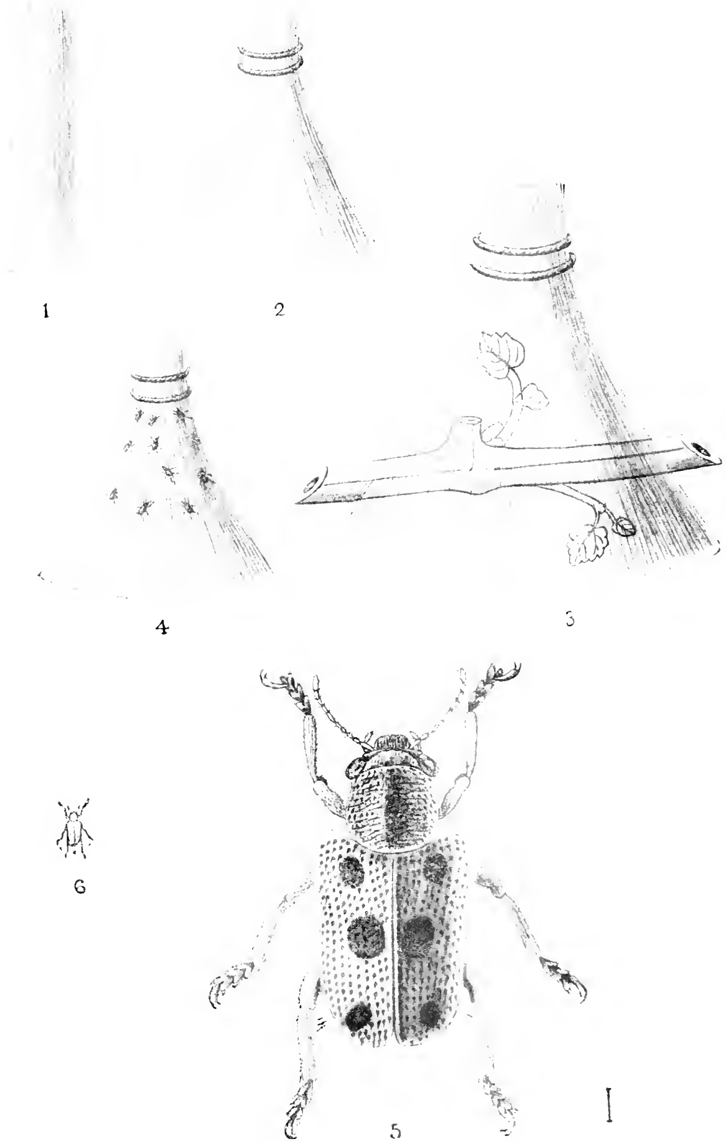
THE GROUNDNUT LEAF-MINER.—The most injurious insect enemy of the groundnut in India is the leaf-miner (*Anacampsis nerteria* Meyr), known in South India as the "Surul puchi." This crop pest is appearing on groundnut wherever grown in the

PLATE XXIX.



A. J. I.

1, 2, 3, 4, Contrivance to catch Insects on Grape Vines.
5, 6, Scelodonta strigicollis.

Madras Presidency. The cultivation of groundnut is extensive in some districts of Madras and is spreading.

The leaf-miner is a very small caterpillar which hatches from a tiny egg laid on the leaf; on hatching, it eats into the tissue of the leaf and mines within, causing an irregular blotch which turns brown ; the affected leaf withers and falls off if badly attacked; the full grown larva emerges, webs the leaf up or joins two leaflets together with silk and pupates there in a light silken cocoon. A very small dark moth then emerges and lays eggs. The whole life cycle is about one month, and the broods succeed one another throughout the year.

The pest is most easily recognized by its work, a badly affected field turning brown as if fire had passed through and burnt the plants. In bad seasons the losses are said to be very heavy. This pest must gain a wider range, as groundnut cultivation is extended, unless special precautions are taken. Groundnut is so profitable that taking good and bad years together, the cultivator can afford to neglect the pest. Profits would be considerably larger if the pest was checked at an early stage. Usually the cultivator makes little or no effort to protect his crop. This leaf-miner has not yet been identified north of Bellary. Groundnut was grown for the first time at the Hagari Farm in Bellary in 1906-07, and the pest was found on the first crop.

This pest is now under investigation in Madras and a full account will be issued in due course. This enquiry will possibly lead to recommendations regarding efficient practical remedies. Meantime I advise that (*a*) the appearance of the insect in new places should be keenly looked for, (*b*) such appearance should be promptly reported to me in order that vigorous methods may be quickly adopted to prevent the pest spreading in a new district.

In districts where the pest is already established, serious damage can be prevented by continual care in removing affected leaves and burning them and by the use of trap crops and trap lights. A trap crop may be successfully used when local conditions have been fully studied. The moth comes readily at night to the light and can be captured in abundance. It is as yet doubtful

how far the suggested means will check the pest when firmly established. They will be useful when it first appears.

The pest is not bad in every season and is checked by a Hymenopterous parasite; but should the insect be introduced to a new locality without its parasite, the effects may be serious. In South Arcot (Madras) one of the difficulties consists in the fact that there is always groundnut growing, either irrigated or rain-fed; consequently there is no season when the pest has no food-plant and it multiplies throughout the year.—(H. M. LEFROY.)

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THE POTATO MOTH.—An enquiry is in progress in the Bombay Presidency into the prevalence and distribution of a pest of the potato plant. This pest is the notorious Potato moth (*Phthorimaea operculella*, formerly known as *Lita solanella*); it occurs in Southern Europe, Algeria and Australia and is known to be a seriously destructive insect. There is reason to believe that this pest was introduced to India with European seed potatoes some years ago. It lives in the potato tubers and is readily carried long distances in them. The moth is a small brownish insect, a little over half an inch across the expanded wings. It can only easily be recognized by comparison with a full technical description.

It is possible that certain measures may prevent the spread of the pest from the districts in which it is now prevalent. Cultivators in any part of India should, however, be very cautious in importing seed potatoes because this pest has done immense damage in other parts of the globe.

The object of present enquiries is to ascertain exactly in which districts of India the pest occurs and whether it can be eradicated. It may or may not be confined to particular districts in Western India. If it is not now present in other potato-growing districts in India, it will probably make its appearance if seed potatoes are imported without proper precautions. Fumigation and other treatment, on lines which will be minutely described by me on application, should be adopted.

If this pest appears in any new locality, immediate information should be sent to me. It is probable that remedial measures can be recommended.

This pest has been investigated by Entomologists in Europe and Australia, and we extract the following information from the account given by French in "Hand-book of Destructive Insects of Victoria," Part II.

The eggs are laid by the moth on the young shoots of the plant; the caterpillars, as soon as they hatch, eat into the root-stock and descend until they reach a tuber, in which they live, making galleries through it in all directions. When full grown, the caterpillar closes the gallery with silk and turns to the chrysalis from which the moth emerges. When the tubers are not near the surface and are properly covered, the caterpillar does not attack them but confines itself to the root-stocks and stems of the plant at and near the surface of the soil.

In addition to attacking the potato plant while growing, the pest attacks the tubers after they are dug and is thus able to pass from one crop season to the next in the stored seed potatoes.

It is not at present possible to investigate all the areas where potatoes are grown, and we draw attention to the insect in order to give timely notice to those particularly interested.—(H. M. LEFROY.)

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THE BOLL-WORM PARASITE.—In consequence of the results obtained last year in re-establishing the boll-worm parasite in the Punjab, boxes of parasites have been sent to Sind and again to the Punjab. In all 100 boxes have been sent to each area and these should be sufficient to thoroughly establish the parasite and restore nature's remedy against this pest. The action which has been taken will, it is hoped, help in producing normal or very much improved conditions in the Punjab and that the Sind crop will be much less damaged than it was last year. The useful effect of the parasite, as it becomes more fully established, will of course be progressive.—(H. M. LEFROY.)

INDIGO SEED SELECTION.—The improvement of processes in manufacturing indigo has received a great deal of attention by specialists and others for many years. Little has yet, however, been done to improve the plant by selection. The Behar Planters' Association have recently appointed an Economic Botanist. He will have great scope for useful work in systematic field selection and in watching the results of cross-fertilization. The superiority of the Java variety under very varying conditions of soil and climate is now very generally recognized. There is little doubt that its cultivation could, with advantage, be greatly extended in India. Mr. Bergtheil in his Report of the Indigo Research Station, Sirseah, 1906-07, however, states that the Sumatrana plant can be grown in Behar on certain classes of soil which are unsuitable for the Java variety. The ordinary field crops grown from Sumatrana or Java seed produce plants of great variety of type. The first step towards real improvement is to isolate type specimens and subsequently determine the economic value of each. As the economic value of a pure type depends upon leaf percentage and indigotin content, it is clear that the field work of an Economic Botanist should be in close touch with chemical laboratory investigations. The importance of an enquiry of this sort and the value of ultimate results to the indigo grower cannot be questioned. Mr. Bergtheil, in referring to the urgent need of selection work on the Sumatrana plant, states that a preliminary step has been taken by growing and examining the different sub-varieties isolated by Mr. Leake in 1903. The following results were obtained :—

Variety.	Percentage leaf content of plant.	Percentage content of indigotin in leaf.
Moltan	51·3	·825
Sukker (Sind)	45·8	·757
Hissar	51·0	·75
Rohtak	51·5	·742
Dharwar (?)	46·6	·742
Meerut (?)	46·7	·725
Delhi	48·3	·705
Muzaffargarh	49·6	·697
Dera Gazi Khan	47·6	·66

The Laboratory investigation indicated that the Multan type was the most desirable to establish, but in the field this type was less vigorous in growth than any of the whole series. The best plants were grown from Delhi and Meerut seed. Hissar and Rohtak plants were of poor growth and showed a tendency to early flowering, which is an undoubted disadvantage. It is considerations such as those above referred to and the practical experience gained by close observation which will influence an Economic Botanist in his selections. His work will not benefit the indigo planter until the seed of type-plants, produces first on experimental plots and then on larger demonstration areas plants which are absolutely true to variety. Meantime the Behar Indigo Planters' Association have established seed farms. A note issued recently by the Sirseah Committee shows that the first crop of Java seed realized Rs. 10 per maund which, owing to an unfavourable season, was less than the cost of production. For sowings in 1908, members of the Association will be charged Rs. 15 per maund. The Committee points out that they have gained experience in the methods of seed cultivation and have been able to sow the Association seed farms with selected seed. The indigo planters should appreciate this work, but the term *selected seed* as used is only comparative and in a sense inaccurate. There is no indigo seed obtainable in India on a commercial scale which can produce a crop with all the plants true to variety, and therefore such seed should not be accurately described as "Selected."—(EDITOR.)

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GREEN MANURING.—Green manuring is practised in many parts of India, but there seems to be room for extension especially in those regions where the rainfall is sufficient for growing a cold weather as well as a rains crop. Last rains at Pusa a field of about 40 acres, which had just been broken in from jungle and which was in very poor condition, was sown with *Sanai* (*Crotolaria Juncea*) which was ploughed in early in September. This was followed by oats as a cold weather crop, no other manure being applied. The crop yielded an average

of 25 maunds of grain per acre, and this notwithstanding that no rain fell from some weeks before the crop was sown until after it was in ear. Green manuring is not expensive—it is considerably cheaper than a rains fallow—and it is easy. The chief precaution to observe is to plough the crop well in and to consolidate the surface afterwards to prevent loss of moisture.—(E. SHEARER.)

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ANTHRAX.—In connection with enquiries made by the English Board of Agriculture into the outbreaks of anthrax amongst animals in Great Britain, it was suggested that infection was possibly introduced by oilcake or oilseeds imported from India. The suspicion was induced because certain affected animals had been given Bombay cotton cake as part of the daily ration. In order to investigate the matter, the Secretary of State, advised by the English Board of Agriculture, asked the Government of India to institute enquiries. The information collected in India goes to show that in threshing oilseeds under the feet of bullocks there is risk of contamination to a certain extent. The oilseeds exported from India are, when expressed for oil in European countries, first ground into coarse particles. The 'meats' thus produced are then subjected to a high temperature by superheated steam in order to open the oil cells and allow free extraction of oil. It is believed that such heat will destroy any possible source of anthrax infection.

The feeding of Indian oilseeds as such to cattle in Europe may be a source of infection, but it is hard to understand why Indian agricultural produce should be viewed with special suspicion. In any case cotton seed cake made in England from Indian cotton seed is a most unlikely source of infection.—(EDITOR.)

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THIRD AGRICULTURAL SHOW AT ONGOLE (MADRAS).—The Third Annual Agricultural Show was opened on the 27th February last, and extended over three days. The Show was an unqualified success, and keen interest in it was evidently taken

by the native gentlemen who constitute part of the local committee.

Ongole is considered a suitable centre for an annual show as it is in the centre of a good cattle breeding tract and is also on the railway. The reports connected with this year's show indicate in decided terms—(*a*) that the Ongole breed of cattle has more than a local reputation ; (*b*) that there is a demand for these cattle from other parts of India and from abroad ; (*c*) that to satisfy these demands in future years, strenuous efforts should be made to maintain the purity, and, if possible, to improve the breed.

The commercial results of the show in the cattle section were encouraging. Cattle to the value of Rs. 15,000 were sold. The report gives, however, a note of warning to breeders because the sales would have been much greater but for the high prices demanded. There is a limit to prices obtainable. At the same time owners should be congratulated on keeping their best cattle, even if tempting offers are made. The breed will deteriorate if the best breeding cattle *are exported* from the district. The measurements of the bulls, which carried off the 1st and 2nd prizes, are uncommon for Indian cattle. Each bull was well over five feet in height behind the hump and well over seven feet in girth.

1,023 animals were exhibited. In comparison with former shows, cows and heifers were better represented than work bullocks and bulls. There were increased entries in the classes for buffaloes and sheep. The sheep had good fleeces.

Prizes were offered for animals fed solely on prickly pear, but although the usefulness of this fodder has been proved in famine times, it is a doubtful policy to encourage feeding cattle on such stuff ordinarily. The specimens of cattle which were shown did not indicate that prickly pear contained much nutriment. Cattle breeders would be well advised to give more attention to storing nutritious fodder in time of plenty and thus obviate the necessity of using poor substitutes when the pinch of famine comes.

Some other features of the show are specially noteworthy, *viz.*, (*a*) the delivery of lectures on agricultural subjects; (*b*) demonstrations showing the practical utility of particular agricultural implements; (*c*) the exhibition of blankets and carpets made from the wool of Madras sheep.

It is suggested that if local sheep breeders would show some enterprise in breeding sheep with white wool of good quality, a local industry in blanket and carpet making might achieve commercial importance. White wool can, of course, be dyed to any desired colour.—(EDITOR.)

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REFINED SUGAR.—Dr. Lehmann, the Agricultural Chemist to the Government of Mysore, sent to the Inspector-General of Agriculture in India a sample of light-coloured clean sugar of good grain with the following note:—"At Cawnpore this year we saw the Hadi process of sugar-making. I was surprised at the light colour of the refined sugar. We were told that that could not be produced if lime were used. I strongly advocate liming to neutrality. That is condemned by nearly everyone in India because it is said to give such a very dark sugar. I should like to undermine that general impression. I am sending you a little sample of sugar made here this year. The juice was limed to slight alkalinity (that is, very slightly overlimed). Red litmus turned faintly blue when put into the limed juice. The juice was boiled down in an ordinary iron country sugar pan and centrifugalled in a small laboratory centrifugal machine intended for all sorts of conditions of work." —(EDITOR.)

LITERATURE.

THE FIBRE ALOE. BY M. HAUTEFEUILLE. (Article in the Bulletin Economique of Indo-China, July 1906, No. 54.)

IN 1904 M. Hautefeuille was commissioned by the French Government to investigate the question of introducing the Fibre Aloe on a commercial scale into French Indo-China. During the investigation M. Hautefeuille visited British India, in order to see for himself the existing plantations. His conclusions, containing some useful general information about this plant, are given in an article published in the Bulletin Economique of Indo-China.

The author describes his visits to the agave plantations in India. He criticizes very sharply the attempts to extract fibre profitably from agaves planted along the railways. He considers that the industry cannot be profitable unless regular plantations are formed in compact blocks.

There exist in India, according to the author, only two plantations of importance. One is that of Dr. Süter, at Powai, near Bombay, and the other at Dauracherra, in Assam, under the management of Mr. James Hunter. The author's criticisms of the Powai plantation are full of interest. The samples of fibre, which he had seen in Europe from this plantation, were of a very high quality. They were reported to be extracted from *Agave americana*. M. Hautefeuille wished, therefore, to see whether this species really did produce fibre of such merit. He found that the plants at Powai were of several species. Some were certainly sisal agaves, and the author holds that it is not certain that *Agave americana* produced the superior samples of fibre above referred to. Speaking of the plantation generally, he considers that there should be more uniformity in the soil,

the situation, the cultivation, and the species of agaves cultivated. The climate with a very dry period followed by a very wet one is trying to the plants, especially those growing in the valley bottoms : the soil is in places thin and light with a rocky subsoil and in other places of a clay consistency : some plants are grown under shade, others in the open : the plants vary in age, and the produce does not keep the extracting machine running regularly.

Of the plantation at Dauracherra, M. Hautefeuille is able to speak more highly in regard to its management, but he considers that the climate of Assam is not quite suitable for profitable work. The agaves in growth compared unfavourably with those in the plantations of Yucatan. He noted the splendid development of some 12 years old fourcroyas, which require a far more humid climate than the true agave, and he thinks it probable that the cultivation of *Fourcroya gigantea* might be more profitable than that of *Agave sisalana* in Assam.

A visit was paid to Tirhoot, where Mr. Hill and Mr. Coventry had each, side by side, plantations of agave and ramie. Though the appearance of the country at the time was one of extreme drought, yet there was in reality no lack of moisture. The plantations of agave were not looking healthy.

The author believes that in no part of India does *Agave americana* produce fibre of better quality than that of *Agave sisalana*, and he further states that when Dr. Süter, in the *Journal d' Agriculture Tropicale* of January 1902, affirmed this superiority, contrary to the assertions of Professor Warburg, of Berlin, the value of the opinion was unreliable, because it was based on wrong nomenclature of species.

M. Hautefeuille states that he saw no really thriving agave plantations in any part of India. He believes that existing plantations have been established under unfavourable conditions of soil, climate, etc. He suggests that the *Agave rigida* might be successfully tried in the rocky elevations of Southern Peninsular India and in certain waste portions of the Punjab and Rajputana. He considers that the cultivation is difficult and requires for suc-

cess special knowledge. He, accordingly, indicates the lines on which an experimental plantation should proceed. He deals with the essential characteristics of climate and soil and the choice of variety. He then goes on to discuss fully the methods of cultivation and extraction which should be adopted, and in conclusion he gives us the economic side of the question, going somewhat fully into details of outturn, cost of working and value of product. The author lays stress on the fact that there is the greatest difference between growing moderately healthy plants under special conditions and growing plants on a large scale for profitable fibre production. The quality of the fibre, the rate of growth of each plant and the period of existence, are not factors which are considered when planting for ornamental purposes. The agave is moreover very particular in its wants; indeed, in Yucatan, the cultivators will name a soil at first sight as being a "Chelem" soil or "Sarci" soil, these being the particular varieties of agave which for each soil are suitable. The varieties of real economic importance for India are mentioned. The whole paper may be recommended to any one interested in agave cultivation in India.—(R. C. Wood.)

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Indian Insect Pests. By H. M. Lefroy, M.A., F.E.S., F.Z.S., *Imperial Entomologist, Pusa.* (Printed at the Govt. Central Press, Calcutta, 1906. Pp. 300 and 365 Illustrations. Price, Re. 1-8 or two shillings.)

Among the recent publications of the Agricultural Department in India is a volume entitled "Indian Insect Pests" by H. Maxwell-Lefroy, Imperial Entomologist. This work is divided into four parts. In the first part, a brief summary is given of familiar facts relating to insects and insect life. Part II deals with the origin of insect pests, preventives and remedies. These two parts are written in plain words in a connected manner, and introduce the reader to the salient facts of Entomology as applied to Agriculture. Technical terms are not used. The substance of these chapters applies not only to India but universally. Part III discusses the more important pests of the

staple crops of India, omitting tea, coffee, rubber and such other crops yielding economic products as are more important to European planters than to ordinary agriculturists. The author has, in fact, dealt with the injurious insects which affect in greatest degree the material prosperity of the Agriculture of India. The illustrations which are given will aid the reader to recognize important injurious insects in the field. Simple remedies are recommended. The information which is given about the life-history and habits, should enable any intelligent person to check the ravages of the more destructive species. Part IV deals with insects attacking grain and cattle; exhaustive treatment is not aimed at, but only such information is given as should be familiar to every agriculturist. Beneficial insects are also discussed. The more common kinds are illustrated. In Appendix A, the author gives tables of weights and measures and information about preparing insecticides and simple appliances, etc. In Appendix B, the methods in use for collecting, pinning and setting insects, are described, with a short account of the best methods of study and observation. This is intended for those who may wish to study insect pests, or are interested in insect life generally.

Mr. Lefroy's book contains 300 pages and over 350 illustrations. It is bound in cloth and is sold at Re. 1-8 (two shillings) by booksellers in India and Europe. It is the only work which deals with the Economic Entomology of any portion of the tropics of the East, and in a practical way with pests attacking, in the tropical East, such important crops as cotton, rice, sugarcane, maize, pulses, groundnut, oilseeds and fruit. It should be in the hands of every enterprising agriculturist in India and the East. It is printed and published by the Government Central Press, Calcutta.—(EDITOR.)

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THE USE OF PRICKLY PEAR AS CATTLE FODDER. (Bulletin No. 4, Issued by the Central Agricultural Committee, Madras, and printed by the Superintendent, Government Press, Madras. Price, 3 pies.)

THE Madras Department of Agriculture has published, in Bulletin form, a summary of experiments carried out in the past,

with a view to ascertain the value of Prickly Pear as Cattle Fodder. Most of the work done in India has been carried out in the Madras and Bombay Presidencies with very conflicting results. Systematic investigation, on a sufficiently large scale, is necessary, in order to arrive at definite conclusions. Different breeds of cattle should be dealt with, also various methods of preparing this fodder for consumption. It is necessary to settle the question whether this plant can be satisfactorily fed to all Indian breeds of cattle as a supplement to other food stuffs in time of famine. The question has certainly not yet been settled by such information as is now on record.—(T. F. MAIN.)

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THE IMPROVEMENT OF SUGARCANE BY SELECTION AND HYBRIDIZATION. BY SIR DANIEL MORRIS, K.C.M.G., &c., AND F. A. STOCKDALE, B.A. (West Indian Bulletin, Vol. VII, No. 4, 1906, Pp. 346. Price, 6 pence.)

THE West Indian Bulletin, Vol. VII, No. 4 of 1906, gives an instructive account of work done by the Imperial Department of Agriculture, West Indies, in the improvement of Sugarcane by Selection and Hybridization. The paper has been prepared by Sir Daniel Morris and Mr. T. A. Stockdale. The writers admit that the great expectations, once held regarding seedling canes, have not been fulfilled. They, however, mention numerous examples of success. There is no doubt canes of definitely known parentage have been produced which have high economic value as regards (*a*) disease resistance, (*b*) heavy weight of cane, and (*c*) high sucrose yield.

The pamphlet consists of two sections. The first gives a historical summary of the development of the method of hybridizing sugarcane. The second describes work of this class done in the chief cane-growing countries. Before 1887-88, it was generally believed that sugarcane produced no fertile seed. About that time the researches of Soltwedel, in Java, and Harrison and Bovell, in Barbados, showed that sugarcane, at times, did bear fertile seed. This discovery led to systematic work in the West Indies, and British Guiana is raising improved races of seedling

canes. Practical difficulties in the work of cross-fertilization arose because of the very large number of very minute flowers on each inflorescence.

In 1894, it was discovered that some canes did not bear fertile pollen, but produced flowers which were otherwise normal. Seedlings obtained from the pollenization of such flowers were necessarily the result of cross-fertilization.

In 1904, Lewton Brain demonstrated how flowers could be emasculated while still very young. This operation requires considerable skill. It has to be done in the field on a high platform, because a good crop of cane is usually 8 feet or more in height, and under a dissecting microscope. It is easy to cross-fertilize the emasculated flowers, and in recent years thousands of seedlings have been raised annually in many cane-producing countries.

Mr. Barber's work in trying to produce new varieties of cane in Madras is referred to, and it is suggested that the burning dry air in India is unsuitable to the successful raising of seedling canes, and that therefore the cultivation of selected "sports" is a more likely means of obtaining in India improved varieties. The term "sport" is applied to a single cane which differs in colour and generally in other characters from the other canes which are produced from the same root system. This variation is a comparatively common feature in the fields of cultivated cane in India and in other countries.—(T. F MAIN.)

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A NOTE ON THE DUKI FIG-TREE BORER OF BALUCHISTAN (BACTOCERA RUBUS). BY E. P. STEBBING, F.L.S., F.Z.S., F.E.S., *Imperial Forest Zoologist to the Government of India* (Forest Bulletin No. 10 of 1907. Pp. 7 and Plates 2. Price, annas 7 or 9*d.*)

THE Imperial Department of Forestry in India has published in Bulletin No. 10. a Note by Mr. E. P. Stebbing, on the Duki Fig-tree Borer of Baluchistan (*Bactocera rubus*). It appears that this borer was first noticed attacking fig-trees in 1905 by Mr. Turner, the Extra Assistant Commissioner of Duki. It was

at first thought that the insect was identical with the willow tree borer, but Mr. Stebbing, with the co-operation of Major Kemball, Political Agent, Loralai Agency, Baluchistan, has proved this supposition to be erroneous, and has identified the insect as being the one above-named. It has been ascertained that few trees are fatally injured by this insect, but this is probably due to the fact that the insects are not yet very numerous. The whole of the life-history has not yet been worked out, but Mr. Stebbing is able to suggest a few precautionary and remedial measures, which, if carefully carried out, are hoped to be sufficient to keep the insect in complete check. Mr. Stebbing is of opinion that this insect exists throughout Baluchistan.—(T. F. MAIN.)

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TOBACCO BREEDING. BY A. D. SHAMEL AND W. W. COBEY. (United States Department of Agriculture, Bureau of Plant Industry, Bulletin No. 96, pp. 71, plates 10 and figs. 14.)

BULLETIN No. 96 of the Bureau of Plant Industry, recently published by the United States Department of Agriculture, describes in detail the exhaustive work which is being carried out by Messrs. A. D. Shamel and W. W. Cobey on Improved Methods of Tobacco Cultivation. These two scientists are carrying out a most searching enquiry into all possible means of improving the tobacco plant. One striking fact brought to light by these investigations is that a change of seed on a large scale is extremely bad practice. A particular variety may, by change of environment, not only lose valuable characters but acquire undesirable qualities. The Bulletin discusses minutely the *Control* which it is possible to exercise over such characters as the number of suckers and leaves produced on a plant, the shape, size, venation, aroma and burning qualities of the leaf, resistance to disease, early maturity, etc. Methods of testing the burning quality of the leaf are fully described. Systems of keeping records for use in the field and for permanent reference are minutely explained. The Bulletin concludes with a description of several valuable new varieties of tobacco which have been obtained by cross-fertilization.

The authors, however, have no high appreciation of the value of cross-fertilization in improving a variety within itself, the first effect being to break up a type. Useful hints on the selection of seed are given. The Bulletin is well illustrated with 10 plates and 14 figures.—(T. F. MAIN.)

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SCIENCE IN SUGAR PRODUCTION. AN INTRODUCTION TO THE METHODS OF CHEMICAL CONTROL. BY T. H. P. HERIOT. (Published by Norman Rodger, Altrincham, England, 1907. Pp. 108.)

THE object of this book is to bring the methods of science within easy reach of the practical sugar-maker. This endeavour is amply fulfilled. The author gives in simple language a true account of the chemical processes which take place during the manufacture of sugar. The book deals with more than the scientific side of the subject. Much useful information of a practical nature is given. Methods of effecting economy in fuel and generally throughout the whole sugar factory are described. In an Appendix a list is given of the apparatus necessary for the various methods described in the text. This book should be in daily use in every sugar factory that does not employ a chemist. —(T. F. MAIN.)

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THE VARIATION IN THE COMPOSITION OF MILK. BY PROF. A. LAUDER, D.SC., *Edinburgh & East of Scotland College of Agriculture.* (Bulletin XI, Pp. 52.)

THE pamphlet describes an investigation of the above subject conducted with two herds of cows in Scotland. The subject is of interest to producers and consumers of milk in India, and the pamphlet is therefore reviewed. In Great Britain, after a searching enquiry, the Board of Agriculture adopted a definite standard of richness of milk, *viz.* :—fat 3·00 per cent, total solids 11·5 per cent. It is pretty generally believed that the milk of individual cows and the mixed milk of a small number of cows, is liable to vary considerably from this standard.

Richmond gives the following as the average composition of 31,120 samples of milk from the South of England during 1905 :—

	Fat %	Total Solids %
Morning Milk	... 3·54	12·53
Evening Milk	... 3·91	12·86

The variation in composition of milk is due to a number of causes which may be divided into two classes, *viz.*, 'Constant' and 'Irregular.' 'Constant' causes of variation are :—

(*a*) Breed.
(*b*) Period of lactation.
(*c*) Effect of the season of the year.
(*d*) Effect due to situation and climate.

'Irregular' causes, which tend to produce sudden variations in the composition of the milk, are :—

(*a*) Sexual excitement.
(*b*) Sudden changes in the weather.
(*c*) Effect of milking at very unequal intervals.

In experiments carried out since the Board of Agriculture fixed the standard composition for milk, Gilchrist, Bryner-Jones and Collins at the Armstrong College, Newcastle-on-Tyne, and Crowther, at Leeds University, have shown that in a number of cases the mixed milk of a whole herd, particularly in the morning, contained less than the standard percentage of butter-fat. Dr. Lauder's investigations were intended (*a*) to test these results ; (*b*) to determine whether the fat content of the morning and evening milk is largely due to unequal intervals between the times of milking ; (*c*) to confirm the view that with properly nourished animals, it is impossible, by feeding, to do more than effect a temporary improvement in the quality of the milk.

The results obtained show that the average quality of the milk obtained from a herd of cows varies considerably at different times of the year. The fat content was well above the standard, till about the middle of January when a gradual falling-off began;

the milk, especially that of deep milking cows, remaining rather poor in quality till June. The analytical results are as follows :—

	Morning Fat.	Evening Fat.
Average for whole year	3·15	3·91%
" January to April	2·85	3·58%

These figures show that the evening milk was considerably richer in butter-fat than the morning milk. The cows were regularly milked at 6-30 A.M. and 4 P.M.

During August 1906 the milking was done at 5-30 A.M. and 5-30 P.M., thus making equal intervals of 12 hours. The following figures show the composition of the milk obtained :—

	Morning 5-30 A.M.		Evening 5-30 P.M.	
	Fat %	Total Solids %	Fat %	Total Solids %
Average	3·67	12·62	3·70	12·42

Thus by making the intervals between milkings equal, the composition of the morning and evening milks becomes practically identical. These results are in agreement with those obtained by other observers.

In the experiments to observe the effect of feeding in the composition of milk, a portion of the herd received, in addition to the common ration, two pounds of crushed oats and two pounds of linseed cake daily. The averages of the results obtained are given below :—

	Average of cows to which increased ration was given.		Average of rest of cows in herd.	
	Fat %		Fat %	
	Morning.	Evening.	Morning.	Evening.
Before change ...	3·03	3·66	3·74	4·48
After change ...	2·81	3·49	3·48	4·05
Difference (—) ...	·22	·17	·26	·43

The experiments were carried out in January and February when, as shown by both sets of figures, the quality of the milk was falling off. The results, which are supported by those obtained by Gilchrist and Bryner-Jones and by other observers

indicate that, with cows already in good condition, increased feeding does not tend to produce any marked improvement in the quality of the milk.

In India the ordinary percentage of butter-fat in cows' milk is much higher than in that of European breeds excepting perhaps the very best of Channel Island Cattle, but variations in quality occur in India under varying circumstances more or less precisely in the same way as in Europe.

Attention is drawn in the report to the value of systematic chemical analysis of milk as a means of selection in forming a herd of dairy cattle. By selecting the good milkers and breeding from these, not only the yield but the quality of the milk of a herd may be gradually improved.—(R. S. FINLOW.)

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THE FERMENTATION OF TEA, PART II. BY DR. HAROLD H. MANN, D.SC. (*Published by the Indian Tea Association, Calcutta,* 1907.)

THIS pamphlet forms a further valuable addition to the author's previous publications on the same subject. During the past six years, Dr. Mann has been more or less continuously studying the fermentation of tea, and within this time we have had no less than five publications from his pen dealing with the matter in its various aspects.

In the present issue, the subject is taken up from the point at which it was left in The Fermentation of Tea, Part I, published in April 1906, and reviewed in our issue of July 1906. The enquiry is now extended to the question of flavour in tea, and some interesting and valuable observations are made on the necessity of plentiful aeration of fermenting-rooms and on the optimum conditions of "firing." It has always been held that the flavour of tea is due to an essential oil contained in the leaf cells. This oil, which is apparently a body of doubtful chemical composition, is said to be contained in very small quantities in the leaf; according to Dr. Mann, "so small indeed that any

measurement of the amount of the oil, by weighing it directly, is absolutely impossible." Under these circumstances, Dr. Mann has devised an indirect method for determining its quantity in a given sample of tea-leaf, on which he bases all his observations on the effect of varying conditions during the fermentation process on the development of the oil. The method, as described, does not seem altogether beyond criticism from a chemical standpoint, but the results obtained by its application to several samples of tea seem to coincide remarkably closely with trade valuations.

The first point, brought out by an application of this method to the study of the process of manufacture, is that a very small proportion of the essential oil is developed during withering, but that immediately the walls of the leaf-cells are broken down by rolling, a rapid formation of oil takes place and speedily reaches a maximum. The rate of formation decreases during fermentation, and is generally complete after three hours from the beginning of the rolling process.

This suggests one of two things; either that the oil is developed by a process of enzyme fermentation which cannot take place until the cell-walls are broken down and the interacting bodies brought into contact, or that the method of analysis is at fault, and that less oil is found in the unrolled leaf solely, because in this condition the unbroken cell-walls prevent the whole being carried over by distillation. The latter seems the more probable explanation. The observation that no appreciable increase in rate of formation of the oil takes place with a rise in the temperature at which the fermentation is conducted, seems also to argue against its being formed during the manufacturing process and in favour of the apparent increase after rolling being due to the method of determination. Against this, we have the fact that an increase in the quantity of oil apparently does take place after rolling, though at a comparatively slow rate.

It is found that an increase of the period of fermentation, beyond about three hours, leads to a decrease in the flavour-giving constituent, and this gives Dr. Mann an opportunity to preach again his excellent sermon on the necessity for absolute

cleanliness during tea manufacture. It is clearly shown by experiments, in which antiseptics are used, that this loss of flavour is due to bacterial action and, since the use of antiseptics is clearly inadmissible in manufacture, the necessity for the only other alternative to reduce bacterial action to a minimum, absolute cleanliness, is clearly indicated. In following this observation of the decrease of flavour giving constituents after three hours fermentation to its further logical application, a practical difficulty arises. In a former publication Dr. Mann has shown that, in order to obtain a leaf capable of giving a liquor of the best pungency and character, four or five hours' fermentation at a temperature of 75°—84°F. is required. He now shows that anything beyond three hours leads to loss of flavour. Can these two requirements be reconciled? In Dr. Mann's opinion the answer is in the negative, and each planter must face the position and make up his mind if it will be more to his advantage to make for "pungency," etc., at the expense of flavour, or for flavour at the expense of pungency, etc. To put it in the author's words, "if flavour is the primary consideration, the fermentation should be as short as possible, consistent with producing a respectable 'liquor'; if 'liquor' is the more important, the fermentation should be as long as possible (up to 4½ hours at any rate), consistent with retaining the most flavour possible."

Some interesting observations are made on the subject of the aeration of fermenting-rooms. Figures are given showing that on an average, 4½ lbs. of fermenting tea-leaf exhausts the oxygen from one cubic foot of air, and the conclusion is drawn that it is necessary to provide for a constant supply of fresh air in the fermenting-room. It is pointed out, however, that any air so supplied must be saturated with moisture, so as to avoid any risk of premature drying of the leaf, and the valuable practical suggestion is made that a constant supply of fresh air should be blown into the room over wet cloth or *khuskhus*.

The last subject discussed is that of "firing." In his previous report, Dr. Mann has shown the importance of rapid firing by tracing the great losses of soluble matter and tannin which result

if anything like "stewing" of the leaf takes place. He now shows that, from the point of view of flavour, rapid firing is equally desirable, since there is a marked deterioration if the leaf is kept at an elevated temperature in a moist condition. Rapid firing can be attained in two ways :—(*a*) by working at a high temperature; (*b*) by having a strong induced draught. The former method is shown to be inadmissible when flavour is a prime consideration, and the use of machines with strong draughts, or of a large number of machines, so that firing takes place rapidly at a comparatively low temperature, is recommended.—(C. BERGTHEIL.)

* * *

REPORT ON EXPERIMENTS IN PUMPING WITH OIL-ENGINES AND CENTRIFUGAL PUMPS IN 1905-06. BY ALFRED CHATTERTON.

(Printed by the Superintendent, Government Press, Madras, 1907. Pp. 26, Figs. 8.)

MR. CHATTERTON, Director of Industrial and Technical Enquiries in Madras, has published a report for 1905-06 of his experiments in pumping water with oil-engines and centrifugal pumps. The report is illustrated with many instructive diagrams, and gives valuable information based on the results of elaborate experiments. It embodies information in regard to (1) the actual cost of raising water under different conditions; (2) the amount of irrigation water required under varying conditions as regards crop, soil and rainfall; (3) the advantage of employing small oil-engines and pumps for the irrigation of intensive cultivation such as that of garden crops on small areas; (4) the quantity of water available for lift irrigation throughout the year from various sources of supply, such as wells, open rivers, tanks and natural lakes; (5) the distribution of underground water in various parts of the Presidency and practical means of making larger use of it than at present; (6) the efficiency of different oil-engines and centrifugal pumps, the practical methods and the precautions to be taken in using them; and (7) the general arrangement of installations.

The report, like Mr. Chatterton's work in general, is thorough, and cannot be briefly summarized without the omission of points of great practical value. It necessarily appeals more to those who have some technical knowledge of an engineer's work than to the ordinary reader. An educated capitalist can utilize the report to his advantage; an ordinary cultivator would gain very little advantage from even a free and easy vernacular translation without numerous explanations in very simple language.

In various parts of India *intensive* cultivation is practised with extraordinary success. For such cultivation in many places, expensive well irrigation is used with great advantage for such crops as sugarcane, tobacco, ginger, turmeric, and many more which it is unnecessary to particularize. These crops are regularly rotated and are taken in rapid succession. The land is continuously occupied, and well irrigation by bullocks and the ordinary leather bag water-lift costs well over Rs. 100 per acre per annum. If there is a sufficient spring of water in a well in ordinary seasons to justify the use of an oil-engine and pump, Mr. Chatterton's figures clearly indicate that there will be great economy in their use. Any intelligent reader can determine from the report the conditions under which oil-engine and centrifugal pump can be economically used for the purposes of irrigation. Mr. Chatterton points out that experience has shown that it is not necessary to employ expensive men to drive these engines. They work fairly satisfactorily in the hands of Native drivers on wages of Rs. 10 to 15 per month, provided the drivers implicitly carry out the instructions given to them and carefully attend to lubrication and the tightening of nuts and bolts that may accidentally become slack.

For estimating the cost of pumping water under good working conditions, Mr. Chatterton takes an installation consisting of a $7\frac{1}{2}$ H.-P. oil-engine and a 4″ pump with a maximum lift of 25 ft. This plant will raise 18,000 gallons of water per hour, provided there is sufficient water available for 12 hours' running per day. Including charges for installation, interest, depreciation, mainten-

ance and repairs, the working expenses are estimated as follows :—

			Per day.
1.	Liquid fuel, 9 gallons @ 3 as. per gallon	...	Re. 1-11-0
2.	Driver @ Rs. 15 per mensem ...	...	„ 0- 8-0
3.	Lamp and lubricating oil, waste and stores	...	„ 0- 8-0
4.	Interest and depreciation 10 per cent.	...	„ 1- 4-0
5.	Maintenance and repairs 5 per cent.		
		Total ...	Rs. 3-15-0

This gives a total cost of working of Rs. 3-15-0 or Rs. 4 per day. The cost increases as the number of days in the year, during which the engine is not worked, increases. Assuming that the engine works for only 200 days in the year, the daily cost of working comes to Rs. 5-10-0.

I have repeatedly tested the amount of water which is ordinarily lifted per hour by means of the ordinary leather bag worked by bullocks. If the depth of water is about 25 feet, the amount discharged does not usually exceed 1,800 gallons per hour or $\frac{1}{10}$th of Mr. Chatterton's figures. The daily cost of manual and bullock-power at ordinary hiring rates comes to 12 annas or about the one-sixth of Mr. Chatterton's maximum estimate.—(EDITOR.)

* * *

WELL-WATERS FROM THE HADHRAMAUT, ARABIA. BY DAVID HOOPER, F.C.S. (Journal of the Asiatic Society, Bengal.)

MR. HOOPER, Curator, Industrial Section, Indian Museum, Calcutta, has contributed to the Journal of the Asiatic Society, Bengal, an interesting article on the value of well-waters containing mineral salts in the Hadhramaut Valley of South Arabia. This valley, which extends over 100 miles parallel to the coast, collects under its sand the water of the high Arabia tableland. These subterranean stores form valuable sources of water-supply in the springs, streams, aqueducts and wells of the valley, and being rich in mineral salts give fertility to the lands irrigated from them. Mr. F. Noel-Paton, Director-General of Commercial Intelligence, during a visit to South Arabia a few years ago, was struck with the fertilizing property of the mineral water of

Hadhramaut and specially with the fine crops of tobacco grown in that region. Cultivation depends upon irrigation, for there is practically no rainfall. Last year Mr. Noel-Paton procured samples for chemical analyses. These have been analysed by Mr. Hooper and contained the following constituents per 100,000 parts :—

	Total Solids.	Lime.	Magnesia.	Potash.	Soda.	Iron.	Chlorine.	Sul. Acid.	Nitr. Acid.
Harith ..	415·5	96·88	9·55	20·60	59·21	2·8	46·5	143·3	·19
Ferath .	383·8	94·96	9·72	18·92	54·39	2·0	30·9	146·2	traces.
Sida .	409·6	87·50	11·10	17·37	58·83	2·5	35·5	151·1	·11

Mr. Hooper thinks the fertilizing properties are probably due to the presence of potash and lime salts and the action of the sulphates in liberating the alkaline constituents from the soil. In this respect the composition of the water differs widely from that of waters of wells in the Bombay and Madras Presidencies which are suitable for tobacco cultivation. The nitrates, which these waters contain, have a high fertilizing effect for tobacco. There are salt or brackish wells in numerous other parts of India. The waters of these have, in some cases, great manurial value, whilst in others the brackishness has injurious effects on nearly all crops. The brackishness deserves searching chemical investigation particularly in reference to the profitable use of the water for tobacco cultivation.—(Editor.)

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* *

Notes on Rubber Cultivation; with special reference to Portuguese India. By Lieutenant-Colonel J. A. Wyllie, F.R.G.S., I.A., and Octaviano Guilherne Ferreira, M.R.A.S. (Published by Higginbotham & Co., Madras. Pp. 131 and 16 Plates. Price, Rs. 4-8.)

This volume, at once a résumé of results so far achieved in rubber cultivation in India and a practical guide to Planters, based on wide personal experience, is commended to all who are interested in this industry. The principal plantation rubber trees are dealt with at considerable length and the relative merits of each discussed, while full instructions are given for planting.

The estimates of expenditure and returns on outlay of capital give promise of a rosy future for rubber planters, and the authors are not inclined to agree with those who fear overproduction in the near future. It must be remembered, however, that rubber planting is still an infant industry, and much must be learned before one can forecast its future with any degree of certainty. Thus Ceara rubber (*Manihot glazorii*), which at first gave but little promise of success, is now finding favour with a good many planters even in Ceylon, and there is little doubt that Ceara can be grown over a very wide range of country. Even the range of Para (*Herea braziliensis*) is likely to be considerably more extended than was at one time thought possible of a tree whose natural habitat is the tropical and marshy Amazon valley. The possibilities of many of the rubber vines also are but imperfectly understood. On the other hand, cheapening of the processes of production is bound to come with advance of knowledge, and again the demand for rubber is sure to respond enormously to any fall in price. Perhaps, in the present state of our knowledge, all we can say with safety is that unless natural conditions place a limit to rubber planting, cultivation will extend until only an average rate of profit is earned on all but the most favoured tracts.

The publishers are to be congratulated on the general get-up of the volume, paper, printing and illustrations being alike good.—(E. SHEARER.)

* * *

FIRST BOOK ON AGRICULTURE. BY C. BENSON, M.R.A.C., *Late Deputy Director of Agriculture, Madras.* (Published by Messrs. Macmillan & Co., Ld., London, 1906. Pp. 166.)

THIS small volume, which has translations into both Tamil and Telegu, has been written for use in primary schools, especially in Southern India. Mr. Benson's intimate knowledge of the agricultural conditions of the Madras Presidency has particularly qualified him for such a task, and he has here combined an exposition of the elementary principles of agriculture with their local application in a very successful manner. The book is written in

a simple and homely style, suited to the reader whom the author has in view, but we have no doubt it will appeal still more to adults, among whom it ought to have a wide circulation. The apposite sayings from the vernacular which head each chapter should, as Mr. Benson hopes, "produce a homely effect on the minds of the parents of the pupils in rural schools," and should do much to engage their interest. We commend the book to all who are interested in Indian agriculture.—(E. SHEARER.)

* * *

CHEMISTRY OF THE PROTEIDS.—BY DR. GUSTAV MANN. (Published by Messrs. Macmillan & Co., Ld., 1906. Pp. xviii + 606. Price 15*s.*)

THE subject of proteid chemistry is one which has of late years become more and more prominent, and we are indebted to Dr. Mann for co-ordinating the literature of this vast and scattered subject.

This work may well find its way to every chemist's book-shelf, for, not only does the author give a clear and concise description of much of the pure chemistry, such as Emil Fischer's work on the mono-amino acids and other decomposition products of albumen, but he also gives what is of almost equal value to the earnest student, a very full series of references to the original papers.

The nomenclature of the subject has always been one of the great difficulties in the way of its study; and Dr. Mann, on more than one occasion, falls into the error of using confusing terms. Notwithstanding this deficiency, however, the book is eminently one for use, and will be well worthy of a place in every scientific library.—(J. H. BARNES.)

* * *

RUBBER CULTIVATION IN THE BRITISH EMPIRE. BY H. WRIGHT. (Published by Messrs. Maclaren and Sons, London. Pp. 100, 2 Photos. Price 2*s.*6*d.*).

THIS booklet contains an account of a lecture delivered before the Society of Arts and deals briefly with the present position and prospects of rubber cultivation in the tropical portions of

the Empire. The high prices obtained for both wild and plantation rubber in recent years have led to the planting of considerable areas in the Malay States, Ceylon and Java, chiefly with Para rubber (*Hevea braziliensis*). The trees on some of these estates have been tapped and excellent rubber has been produced, but most of the area planted up in these regions still consists of young trees. In spite of the extremely optimistic views of the author on the future of the plantation rubber industry and the large profits to be made by extending the area in the East, a perusal of this pamphlet and of some of the recent literature suggests the possibility that the rubber boom is not likely to last and that before very long, the new plantations will produce sufficient rubber to lower the price considerably. It is well to remember the history of the cinchona, tea, coffee and sugar industries, when high prices rapidly led to overproduction and a great fall in prices. There is further the possibility of producing artificial rubber or rubber substitutes at a low price with results similar to those brought about by the manufacture of artificial indigo. Except in some portions of Burma and Southern India, like Travancore, there is not much prospect of the successful cultivation of Para rubber in India, and before any extension of the present plantations in these regions can be advocated, it will be well for planters and Government officers to watch the results of those already in existence. The prospects of Assam rubber (*Ficus elastica*) in Eastern India have been discussed by Dr. Mann in a recent paper in this Journal (Vol. I, Part IV). It appears that Assam rubber is not likely to be of much importance in this country, and it is perhaps not too much to say that India is unlikely to become an important producer of plantation rubber. Some wild rubber is exported every year from Assam and Burma, but the amount is inconsiderable.—(A. HOWARD.)

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* *

SECOND REPORT ON SUGAR MILLS AT BENIPORE FACTORY. BY PERCY JONES.—(Published by the Behar Planters' Association.)

THE Behar Planters' Association have published a 2nd Report on the experiments in Rab-making at Benipore

(Tirhoot) in 1906-07. At the suggestion of Mr. Percy Jones, Government supplied two *Rab*-making appliances (*Bel*). The term "Rab" means crude sugar in a semi-liquid form. In this form the sugar crystals can readily be separated from the treacle by a Centrifugal machine. The Agricultural Department, United Provinces, lent the services of a qualified Inspector and two boiler-men to erect the appliances and to demonstrate proper working methods to the local men. Mr. Percy Jones reports that he has thus succeeded in making *Rab* of uniform quality, and superior to that ordinarily made in his district. He purchased cane in the field on terms which were satisfactory to the grower and the refiner. The experience gained during the last two seasons has demonstrated that the improved methods of *Rab*-making will be of advantage to such cultivators as can afford to grow cane but cannot afford to set up expensive cane mills and refining appliances. During the last season the Benipore Mill worked under certain unusual disadvantages which are fully described in the report. The margin of profit was, therefore, small. The experiments clearly indicated the necessity for a high speed hand Centrifugal machine. This will be obtained. The experiments which will be carried out during the next sugarcane harvest will be on a commercial scale and Mr. Percy Jones offers a cordial invitation to all concerned to come and watch results. These experiments are intended to show the practical advantages of a cheap installation which will deal with detached areas of cane, each of moderate size, and be capable of turning out refined sugar and molasses, which latter can be boiled down again into saleable *gur*. The interests of the ordinary cultivator are chiefly concerned.—(EDITOR.)

NOTICE.

THESE Memoirs, dealing with scientific subjects relating to Agriculture, will appear from time to time as material is available. They will be published in separate series, such as Chemistry, Botany, Entomology and the like. All contributions should be sent to the Editor, the Inspector-General of Agriculture, Nagpur, Central Provinces, India. Contributors will be given, free of charge, fifty copies of their contributions.

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CONTENTS.

THE DEVELOPMENT OF SISAL HEMP CULTIVATION IN INDIA.

By HAROLD H. MANN, D.SC.,

Principal, Agricultural College, Poona.

In India the commercial cultivation of Sisal Hemp (*Agave sisalana*) and of other allied fibre plants was begun five or six years ago chiefly in Eastern Bengal and Assam. Previously these plants were used mostly for ornamental purposes in gardens and occasionally as hedges for compounds and along railways and canals.

In Eastern Bengal and Assam an industry in Aloe Fibre is now established which will probably flourish. The Agave plantations in this Province extend over considerable areas. These lands were previously unoccupied and were considered unsuitable for the ordinary crops of the country. The cultivation of Agaves and of Mauritius hemp (*Furcræa gigantea*) is likely to become a permanent industry in Eastern Bengal and Assam. The climate seems to suit the latter plant especially. The cultivation of Agaves has also extended into the Bengal divisions of Chota Nagpur, Sambalpur and Behar and, to a less extent, into the Provinces of Madras and Bombay.

In Eastern Bengal and Assam there are two principal suitable areas, one in Sylhet and the other in Chittagong, with smaller developments in Cachar and elsewhere. In Sylhet there are at least six plantations which now each extend to several hundred acres. The largest plantation is at Dauracherra. Its extent is over 1,000 acres and it is owned by a limited liability Company which is not directly connected with any tea estate. Most of

Note.—The present article may be considered as a supplement to a pamphlet by the Author and Mr. J. Hunter, published by the Indian Tea Association in 1904.

the other plantations in Assam are owned by Tea Companies. This secures economic supervision. In Sylhet the total area under Agaves in 1907 is approximately about 4,000 acres and in Chittagong about 1,000 acres, but in the latter division extensive developments are likely in the near future. It is probable that before January 1908 at least 6,000 acres of Sisal Hemp and allied fibres will be growing in the Tea districts of North-East India. The extent of cultivation elsewhere in India cannot be at present estimated, but it is considerable.

I need not repeat the information given in another place (see foot-note, page 323), regarding the characteristics of the plants or the method of their growth and flowering. There are two methods of reproduction and often three. In a period varying from four to fourteen years under Indian conditions, each plant sends up a straight flowering stalk termed a "pole." The plant dies when it poles. The pole produces, where a flower would normally arise, a young plant termed a bulbil, which, when disentangled from the pole by wind or otherwise, falls to the ground and may there take root or can be used for planting out new areas. These bulbils are very tenacious of life and can be transported long distances if carefully packed. If packed moist, they are liable to become rotten.

From many of the species, seeds are produced from flowers in the usual way, but this is not the case with Sisal Hemp.

Some Agave plants have another method of reproduction. In the first or second year after planting and subsequently, root stocks are thrown out. These are commonly called suckers. They can be separated from the parent plant and can be planted out. Our experience shows that among all the species and varieties of Agave and related plants, the true Sisal Hemp (*Agave sisalana*) is the best for India. It grows, when placed on suitable soil, vigorously, and is more profitable than other species under ordinary climatic conditions. The latest experience at Dauracherra (Assam), is that the leaf will yield four per cent. of fibre of which three per cent. is first class, and one per cent. is short and inferior.

In Eastern Bengal and Assam, Mauritius Hemp (*Furcræa gigantea*), owing to particular climatic conditions, will probably thrive better than Sisal Hemp. It grows more vigorously than Sisal Hemp and has so far not been subject to attack by insects or disease. On the other hand, the percentage of fibre obtainable from the leaves is much smaller than from Sisal Hemp. As the leaves are much larger and heavier than those of Sisal Hemp, this may not mean much less fibre per acre, but it would mean that the cost of carriage of leaf for the same amount of product would be considerably greater. The large machines which satisfactorily extract fibre from Sisal Agave would probably be found unsuitable for Mauritius Hemp. There are, however, a number of smaller machines which satisfactorily clean Mauritius Hemp, but these are not economical when large areas have to be dealt with.

In the light of experience I am convinced that true Sisal Hemp (*Agave sisalana*) is the best of all the Agaves for large plantations in India, but if a good fibre-extracting machine for Sisal Hemp cannot be economically provided, then Mauritius Hemp (*Furcræa gigantea*), may possibly be found more profitable in certain parts of North-East India if the fibre in good quality can be extracted in the ordinary country way.

A recent publication* by M. Hautefeuille of the Agricultural Department of French Indo-China states that in India Sisal Hemp was most likely to succeed in the rocky elevations of Southern Peninsular India, and in certain waste portions of the Punjab and Rajputana. Our experience in North-East India is all against the use of rocky elevations, or poor and shallow soils and the waste portions of the Punjab without irrigation will grow practically nothing. It has been proved that in North-East India Sisal Hemp will not grow satisfactorily on poor stony soils, or on the old abandoned tea lands. The plants can only grow rapidly and vigorously if the planting is done carefully and if the land is moderately good. Our conditions of soil and climate may

* This was reviewed in the *Agricultural Journal of India* for July, 1907, by Mr. R. W. B. C. Wood.

not be so generally favourable as those of Yucatan where the plant grows excellently, but it is certain that there is no use devoting anything but fairly good land to the culture of Sisal Hemp in India. On poor soil with deficient rainfall the leaves are short, leading not only to a smaller crop but also to a shorter and much less valuable fibre. I believe that the lack of success in many of the attempts at experimental culture has been due to the selection of soil too poor for the purpose. Other factors may however have influenced results. A perfectly drained soil, as also one which is moderately light, is necessary.

The principal difficulty in the rapid extension of Sisal Hemp culture in suitable districts is the absence of plants. True Sisal Hemp plants are in great demand, whether they be bulbils or suckers. Opinion is generally unanimous that suckers should be planted rather than bulbils. Mr. R. T. Fraser, who has a large young plantation in South Sylhet, is of opinion that the ideal method is to allow the sucker to remain attached to the parent plant until eight to twelve inches high, and then plant it out.

Experimental planting has failed in large measure in India owing to the selection of unsuitable soil, and failures have also occurred because sufficient attention and care was not given to the planting. It is generally supposed that Sisal Hemp is a cheap crop. Some of the first plantations were formed with this idea, and the result has been that the areas so dealt with are notably inferior in growth and more uneven than those which have since been made with greater care. A Sisal Hemp plantation will cost as much as a tea plantation in the first instance. Every plant should be planted carefully with roots well spread out in a pit of soft soil of four to six inches deep and twelve inches wide. The soil should be pressed down hard, immediately watered, and a slight mulch of light branches or forest leaves be placed round each plant. The plant should not be sunk below the level of the crown. The soil should be pressed down so as to leave the plant firm in its position.

Experience has shown that planting is most successful when showery weather immediately follows the planting. March and

April are usually the ideal planting months. In Eastern Bengal and Assam, some areas planted during the height of the rains have been successful, as have others planted with big plants in November and December. But in North-East India planting is most successful in the two or three months of showery weather which precede the breaking of the monsoon.

The distance apart of the plants has been a matter of much discussion. The general opinion is now in favour of somewhat closer planting than was done on the pioneer estates. Eight feet by four feet is the distance now commonly suggested. Mr. R. T. Fraser put his plants out in double rows four feet apart with four feet between plants in a row and then a space of eight feet to the next double line of rows. At Dauracherra, nine feet by four and a half is the common distance. So long as the plants grow equally vigorously, and there is enough space to harvest the leaves, it is evident that the closer the planting the bigger will be the yield per acre, but in Mr. Fraser's planting I fancy that the limit has about been reached.

Plants should be put out big. I have already mentioned that it has been found desirable to transplant young plants when they are eight to twelve inches high. If they thrive they will take root at once and give little or no further trouble.

Especially must the soil be kept loose and free from weeds by hand hoeing round each young plant. This cultivation should be subsequently continued to secure as rapid growth as possible. It is not advisable to grow catch crops on land which is planted with Sisal Hemp. On one plantation in Sylhet an attempt was made to get a crop of cotton when the plants were small. The result was practically fatal to the Sisal Hemp. "The small plants are making slow progress and the plantations will take years to recover if even it does recover at all."*

It is probable that the amount of cultivation usually recommended for an established plantation is less than is actually required for the most profitable results. Among planters in

* From a very well informed article in *Capital*. Calcutta, 8th August 1907.

Eastern Bengal and Assam it is generally considered that by liberal cultivation only can vigorous growth and profitable results be obtained on good or fairly good land. It is essential to keep the ground fairly loose and also free from strong-growing grasses and rank weeds. My insistence in previous publications of the necessity for cultivation, amounting to at least three hoeings or weedings per annum, has been confirmed by more experience.

In the third year from putting out the plants (if they are planted of the size I have suggested), they will have attained a height of from four to five feet, and are then big enough to permit the cutting of a few leaves. The leaves open from a central core, and gradually are pushed out from the centre by the new growth, until they finally reach a position nearly at right angles to the stem. After they become distinctly sloped from the perpendicular they grow no more, but become more mature. Those leaves which have reached a point forming half a right angle with the trunk can with advantage be removed.

In North-East India the season for cutting is limited by the period in which the prepared fibre can be dried. Specially heated drying sheds cannot be economically provided. Drying in the open air, limits the period of cutting between October and June. The method of cutting is very simple, and a good man will cut three thousand leaves a day. An ordinary tree pruning knife with a blade eight inches long, is suitable for this work. The Yucatan pattern of knife could probably be used with advantage in India.

The age when Agave plants "pole" and die in India, affects the success of the industry very largely. In a recent publication* it was stated that "any of the Indian Agaves may flower by its seventh year or even earlier." If this is true of Sisal Hemp there would be no success in planting. It would not pay. Experience at Dauracherra seems to indicate that normally the age of poling is about eleven to thirteen years. Occasionally a few plants pole quite early. I have even seen bulbils poling

* Agricultural Ledger, No. 7 of 1906, by Drummond and Prain.

while still attached to the parent. But such poling is exceptional. Ordinarily leaves can be cut annually from plants which are of three to eleven years old. Three cuttings can be obtained each season before April.

I have said that on a large scale, and with our usual methods of extraction, about $3\frac{1}{2}$ to 4 per cent. of fibre is regularly obtained on the weight of leaves at Dauracherra, and only about half this amount with Mauritius Hemp. On existing plantations the amount of fibre obtained is about half a ton per acre per annum. In the plantations more recently put out and more closely planted this amount may be exceeded.

The crop is bulky and weighty, and as it only yields 4 per cent. of marketable produce, the question of transport of crop and refuse to and from the factory is important. In a large plantation, a system of light tramways would probably solve the problem.

A plantation of six hundred acres of Sisal Hemp can be worked economically with the present machinery. One smaller than this will hardly keep a full-sized automatic machine in full work, and if smaller machines be used, the cost of extraction per pound of fibre is immediately increased.

The machinery for fibre extraction may be divided into three classes, all being run by power. Hand machines like the 'Raspador' formerly used in Mexico, may be suitable for those who contemplate Sisal Hemp culture as a small home industry, but they are not in any sense suitable for use on a plantation scale.

During the early days of a plantation when the leaves are short and the quantity is small, the machine which has in the last three years proved itself the best is the 'Harrison' sold by the Eastern Landing, Clearing, and Forwarding Co., of Calcutta, for about Rs. 300. It has a much smaller rasping or scutching wheel than the 'Raspador' and runs at a much higher speed, being made entirely in iron. It will turn out 2 cwt. of fibre a day and requires two men to work it, with three-quarter horse power to drive the machine. This has been so successful that some of our planters at one time thought it might be possible to work a plantation with a battery of 'Harrison' machines

Though this idea has had to be given up, yet it indicates the opinion held of the work which the machine will turn out.

The second group of machines, which I may call semi-automatic, and in which several leaves are dealt with at once, have not been a great success in India, and I would on the whole prefer a battery of 'Harrison' machines. Their advantage is that they all feed the leaf into the machine from end to end, and so there is much less chance of the fibre being damaged than with the larger automatic type, where the leaves are fed sideways. Their disadvantage is that the fibre has to be drawn back out of the machine by hand after being scutched, an operation involving hand labour and slow working. In a machine put on the market by Messrs. Burn & Co. early in 1906, an attempt was made to get over this difficulty, but the cleaning was not efficient, and while the idea seemed to be good, it was by no means perfected. The automatic machines which are alone suitable for large estates are all of the same general type, and only differ really in the manner of holding the leaf. Two types have only been used in India,—the 'Todd' and the 'Torruella' machines.* The former is the favourite in the Bahamas, the latter one of the best in Yucatan. Both have now been carefully tested in our districts, and it may be stated that :—

(1) The scutching arrangement is best in the 'Todd' machine, the fibre comes out cleaner, and there is less waste.

(2) The gripping arrangement is very much better on the 'Torruella' machine. In the 'Todd' the chain grip has given a great deal of trouble ; it is apt to loosen, and it requires constant attention. The 'Torruella' grip is perfect.

(3) Both of them are apt to clean small and short leaves badly or even miss them altogether.

(4) Neither is suitable for Mauritius Hemp as the leaves are apt to break across the middle.

It is apparently, in our districts, impossible to get the work out of the machine which is claimed by the inventor, and the

* For a description and illustrations of these machines, I must refer to my former publication.

absolute maximum the 'Torruella' can do is 100,000 leaves per day of ten hours with four men and 16 horse power. The 'Todd' does less than this, say 50,000 to 60,000 leaves per day.

I have now to discuss the commercial prospects of the industry, so far as they have changed during the past three years. The accumulating evidence seems to make it clear that my former estimate of the cost of putting out a Sisal Hemp estate is not far off the mark. The cost of the fibre delivered in London from a mature Sisal Hemp plantation of an economical size, will be about £14 to £15 per ton. It may be, of course, that as experience increases, this amount may be capable of reduction, but this has not been possible hitherto. Thus at present the cost of running an estate, including freight of the fibre to London, will be about £7 to £8 per acre per annum. This amount is about the same as the cost in the Bahamas and a little under the cost in Yucatan. The production in these countries is increasing though only gradually, and they are, of course, the principal sources of supply. The export from each of these places, according to the latest returns I have been able to obtain, is as follows:—

Mexico (including Yucatan).

Year.	Bales.	Tons.
1896	397,163	66,194
1897	419,983	69,997
1898	418,972	69,829
1899	445,978	74,330
1900	499,634	83,272
1901	517,519	86,253
1902	......	105,913
1903	......	121,944

Bahamas.

Year.	Pounds.	Equivalent in tons.
1898	1,251,730	559
1899	1,358,682	606·5
1900	1,276,037	570
1902	2,345,311	1,047
1904	2,218,825	990·5
1905	3,040,045	1,357

A few other sources of Sisal Hemp fibre are opening, but the amount produced is as yet very small. The plant is now being cultivated in Guiana, and experimentally in British Central Africa. No less than 611,000 pounds were exported from Hayti in the four months ending January 31st. 1905. An attempt is being made to introduce the culture into French Cochin China and extend it in the Philippines. In Algeria it has been much pushed, but my latest information is that little progress is being made. On the other hand, Indian Sisal Hemp has won a recognised place on the market and is quoted as such. The best of it, too, obtains prices almost if not quite equal to those given for the material from Yucatan.

A good deal of the future of the industry depends on the maintenance of the price of this and similar fibres. And from all that can be seen of the fibre market at present, there seems little fear of a serious drop for some years to come. At the same time one must not forget that the prices have been subject to violent fluctuations in the past, and these may easily occur again in the future. For seven or eight years, however, they have remained remarkably stable as the following figures show. The prices are those on the London market :—

Year.	Sisal Hemp.		Manila Hemp.	
	June.	December.	June.	December.
	£	£	£	£
1900	39	30	39	31
1901	..	42	33	46½
1902	42	40	41½	37
1903	39	36	35	41
1904	35	36	36	42
1905	37	39	39	41½
1906	33	35	43	42½
1907	33½	...	38	...

On the whole, therefore, I think that the additional experience of the past three years has confirmed the conclusion to which I was led in 1904, that in many parts of North-East India, Sisal Hemp fibre can be produced in competition with nearly all—if not with all—the countries and districts in which

it has been tried, that the quality will remain as good as that obtained from America, and that it will be a number of years at least before there is likely to be any such slackening in the annual increase in the demand as to lead to serious overproduction and so bring the price below a remunerative figure. Under these conditions with the additional knowledge we now have of the methods of culture and preparation for market, I think there is every prospect of the building up of a flourishing planting industry in the North-East of India.

AUTUMN RICE OR AMAN PADDY EXPERIMENTS AT BURDWAN IN BENGAL.

By F. SMITH, B.SC., F.H.A.S.,

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AUTUMN Rice, Transplanted Rice or Aman Paddy, is the chief rice crop in Bengal. Experiments were commenced in 1901 on this crop and have been continued up to this year. The following have been carried out :—

A. MANURE—

(1) First series—Quantitative.
(2) Second series—Qualitative.
(3) Third series—Green-manuring.

B. VARIETY—

C. METHODS OF CULTIVATION—

(1) Implements—

(*a*) Sibpur Plough *vs.* Local Plough.
(*b*) Surat Bakhar *vs.* Local Plough.

(2) Sowing—

(*a*) Thick and thin sowing broadcast.
(*b*) Spacing in transplanting.
(*c*) Number of seedlings per hole in transplanting.

D. ROTATION WITH JUTE IN THE SAME YEAR.

Soil.—The soil of the Farm is a poor sandy loam. The following are analyses of average samples of the soil and subsoil of the Farm :—

	Soil 1st 9.″	Subsoil. 2nd 9.″
Insoluble silicates and sand	88·52	87·48
Ferric Oxide	3·60	3·68
Alumina	4·42	5·27
Lime	·34	·33
Magnesia	·34	31
Potash	·31	·32
Soda	·09	·07
Phosphoric acid	·02	·03
Sulphuric acid	·01	·005
Carbonic acid	·04	06
Organic matter and combined water ...	2·31	2·45
	100·00	100·00
Available Potash	·04	·02
Do. Phosphoric acid	·002	001
Do. Nitrogen	·011	·007

The figures denote that the land is exceedingly poor in nitrogen and phosphoric acid, poor in lime, but possibly contains enough potash.

Meteorology.—The following table gives the rainfall of the months from May to November, inclusive, from 1891 to 1906, inclusive :—

	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906
May ...	13·98	3·92	21·84	4·65	5·40	6·93	7·47	0·82	3·16	6·03	4·77	6·50	3·94	6·75	9·52	6·08
June ...	2·85	10·73	11·17	8·77	11 39	17·14	11·26	18·92	11·51	8·04	6·42	6·94	8·98	8·79	1·57	5·19
July ...	14·00	7·94	15·17	13·49	8·47	7·06	11·53	8·31	24·03	7·79	11·04	9·59	9·81	14·13	34·14	12·30
August ...	15·54	3·48	4·56	10·52	4·87	10·18	14·77	16·45	10·19	8·79	8·26	7·65	14·15	8·83	14·80	17·68
September	1·82	6·81	12·91	5·14	7·96	9·33	8·34	13·32	8·96	17·55	8·77	6·91	7·96	3·62	10·23	13·58
October ...	0·48	3·92	5·16	3·89	3·70	*Nil.*	6·36	3·22	3·66	0·15	0·11	1·50	6·76	0·05	4·44	6·90
November	0·25	1·93	0·18	1·63	*Nil.*	*Nil.*	0·27	*Nil.*	*Nil.*	*Nil.*	3·16	0·09	1·20	0·01	*Nil.*	*Nil.*

The figures of this table denote that, when the rain falls fairly evenly throughout the month, a normal season for the paddy crop requires 10·17″ in June, 12·32″ in July, 11·49″ in August and 8·59″ in September. It is exceedingly important that the early rainfall should be sufficient to allow of transplanting by the middle of July, otherwise the outturn of the crop is very appreciably diminished. The date of transplanting

and the amount of rainfall in paddy cultivation are very important factors. This has been clearly demonstrated during the last three years. In 1904 the yield was diminished 30 per cent. through drought at flowering time. In 1905 the yield was again diminished 30 per cent. by the abnormal July rainfall of 34·14″ in contrast to an average of 12·32″ making transplanting impossible before August. In 1906 the outturn was diminished 50 per cent. owing to late transplanting in August due to the June rainfall being above 5″ below the normal and the inability of the canal authorities to supply water in July.

Experiments.

A. Manure.—Three series of manure experiments have been carried out, *viz.* :—

Series first.—Applying definite quantities of certain manures without any analysis.

Series second.—Applying the same manures in quantities calculated on analysis to supply 50lbs. nitrogen per acre (excepting bonemeal, which was taken to supply 30lbs. of nitrogen per acre).

Series third.—Green manuring.

Manures in kinds and quantities as stated below were employed. Patna paddy, a medium coarse variety, was employed in each series.

General treatment of the paddy crop.—The following treatment, which applies to all the experiments, was followed. The land was ploughed five times and harrowed twice to obtain the necessary condition for transplanting. Up to 1905 the land was allowed to lie after the paddy harvest till May before ploughing up. Since then the land was ploughed and cross-ploughed immediately after the harvest. Seed was sown in seed-beds in the first week of June and seedlings were transplanted in the first week of July when possible. The crop received one weeding and was harvested in the second week of December. Cowdung was spread in the second week of June, castor-cake and bonemeal in the third week of June, and saltpetre was applied as a

top-dressing three or four weeks after transplanting when the water had gone below the surface of the land.

Series 1. Quantitative series :—

The object of this series is to ascertain the relative merits of cowdung, castor-cake, bonemeal by itself, and bonemeal together with saltpetre, as manures for Aman paddy. This experiment was commenced in 1891 and has been continued ever since. Manures were applied in definite quantities according to the following table which gives the average yields of grain and straw for the past sixteen years.

		Average yield in maunds (80 lbs.) per acre for 16 years (1881—1906, inclusive).	
		Grain.	Straw.
Cowdung,	100 maunds	$41\frac{1}{2}$	$55\frac{1}{3}$
Unmanured		$18\frac{1}{5}$	28
Castor-cake,	6 maunds	$36\frac{3}{4}$	$55\frac{1}{4}$
Cowdung,	50 maunds	$40\frac{1}{8}$	$55\frac{3}{4}$
Unmanured		19	$32\frac{1}{8}$
Bonemeal,	3 maunds	42	$60\frac{1}{5}$
Bonemeal,	6 maunds	$45\frac{1}{2}$	$71\frac{1}{8}$
Unmanured		$20\frac{1}{2}$	$32\frac{1}{3}$
Bonemeal, / Saltpetre,	3 maunds / 30 seers	$50\frac{3}{4}$	$73\frac{5}{8}$

Hence the average outturn of the three unmanured plots for 16 years was $19\frac{1}{5}$ maunds of grain and 32 maunds of straw per acre and the increase due to the manures was :—

		Grain. Mds.	Straw. Mds. per acre.
Cowdung,	100 maunds	22	$23\frac{1}{3}$
Cowdung,	50 maunds	21	$23\frac{3}{4}$
Bonemeal,	3 maunds	23	$28\frac{1}{5}$
Bonemeal,	6 maunds	$26\frac{1}{2}$	$39\frac{1}{8}$
Bonemeal, / Saltpetre,	3 maunds / 30 seers	$31\frac{3}{4}$	$41\frac{5}{8}$
Castor-cake,	6 maunds	$17\frac{3}{4}$	$23\frac{1}{4}$

The results demonstrate that:—First, 50 maunds of cowdung gives almost the same outturn as 100 maunds. The small increase of outturn does not justify the application of the extra 50 maunds of cowdung. Second, 3 maunds of bonemeal is better than 6 maunds for the small extra yield obtained by the 6 maunds

is more than discounted by the cost of the extra 3 maunds. Third, an application of 30 seers of saltpetre as a top dressing in addition to the 3 maunds of bonemeal gives an increased yield over the bonemeal of $8\frac{3}{4}$ maunds of grain and $13\frac{1}{2}$ maunds of straw, an increase that repays many times over the cost of the $\frac{3}{4}$ maund of saltpetre. And fourth, castor-cake gives an increased yield of $17\frac{3}{4}$ maunds of grain plus $23\frac{1}{4}$ maunds of straw, and should not be forgotten by those who can obtain it at a cheap rate, or cannot procure the other manures.

Accordingly, the results of the experiment demonstrate first, the efficacy of 3 maunds of bonemeal plus 30 seers of saltpetre, and, second, 50 maunds of cowdung as manurial application per acre for paddy on such a soil.

The question of manures will ever remain the problem of the individual cultivator as it is the tendency of every piece of land to be different from its neighbour, and we cannot guarantee what has taken place in one area will also happen in another. Still it is very probable that in Bengal, owing to the few geological formations, fairly large areas of uniform composition are to be found, and the same manures should have the same effect on soils of a similar composition. The Burdwan Farm soil is very poor in phosphoric acid, lime and nitrogen. Bonemeal supplies chiefly the two former constituents while saltpetre supplies the last. Soils in the neighbourhood of the farm should be similarly affected by an application of bonemeal and saltpetre. Anyone can detect whether his soil is poor in lime or not. Let him take several samples of soil from his field, mix them together and pour on dilute hydrochloric acid. If no bubbles are given off, the soil is very poor in lime and available phosphoric acid and an application of manure is necessary. Let every cultivator try a small area for himself, and if satisfied with the results, he can increase the area the second year. Cowdung is a general manure and may be applied with benefit by every cultivator.

The following table gives the annual outturn of grain and straw for the past sixteen years :—

Manure applied per acre.	1891. Grain.	1891. Straw.	1892. Grain.	1892. Straw.	1893. Grain.	1893. Straw.	1894. Grain.	1894. Straw.	1895. Grain.	1895. Straw.	1896. Grain.	1896. Straw.	1897. Grain.	1897. Straw.	1898. Grain.	1898. Straw.
Cowdung, 100 maunds ...	50 1/8	61 3/4	46 1/4	58 5/8	43 1/4	54 3/4	41 1/8	53 1/5	42	53 1/2	40 1/2	49 3/4	39	45 1/2	39 7/8	51 3/4
Unmanured ..	19 5/8	32 1/2	15 1/2	20 1/8	16 3/4	21 3/8	16 5/8	19 5/8	16 1/2	26 1/8	15 1/4	27 3/8	13 3/4	29 1/2	17 5/8	28 3/8
Castor-cake, 6 maunds ...	47 1/4	60 3/8	42 7/8	56 7/8	41 5/8	51 3/8	39 7/8	53 1/8	40 1/2	73	39 3/4	70 3/4	38 1/6	64 3/4	38	55 1/8
Cowdung, 50 maunds ...	47 3/8	57 1/8	45 7/8	58 5/8	55 1/2	71 1/8	48	65 7/8	47 7/8	59 1/16	47	60 3/4	42	65 1/2	48 1/6	59 7/8
Unmanured ...	22 3/8	33 1/4	15 5/8	20 3/4	20 1/2	41 1/8	18 1/4	30 1/2	18 3/4	29 1/4	18 1/4	28 5/8	17 1/2	48 3/4	19 3/8	38 1/6
Bonemeal, 3 maunds ...	47 7/8	59 1/4	46 1/4	61 5/8	56 1/2	78 5/8	47 3/4	74 7/8	48 1/5	76 1/2	17 1/3	80	37 1/6	60 1/6	37 5/8	55
Bonemeal, 6 maunds ...	48 3/4	59 3/8	47 3/4	61 5/8	46 1/4	72 1/2	57 7/8	78 1/4	56 3/4	102 1/2	54 1/4	99 1/8	45 1/2	60	44 1/2	55 1/2
Unmanured ...	23 5/8	34 1/4	18 1/2	30 3/4	22 1/4	29 3/8	19 5/8	25 3/4	18 3/4	25	77 1/8	45 3/4	18	36 1/8	19 3/4	36 3/4
Bonemeal, 3 maunds ... Saltpetre, 30 seers ...	57 3/4	69 3/8	57 7/8	63 5/8	58 5/8	78 3/4	58 3/8	79 5/8	58 1/5	104 1/5	54 3/4	104 1/4	48 1/2	86 1/6	48 7/8	69 1/3

Manure applied per acre.	1899. Grain.	1899. Straw.	1900. Grain.	1900. Straw.	1901. Grain.	1901. Straw.	1902. Grain.	1902. Straw.	1903. Grain.	1903. Straw.	1904. Grain.	1904. Straw.	1905. Grain.	1905. Straw.	1906. Grain.	1906. Straw.
Cowdung, 100 maunds ...	40 1/2	49	49 4/5	60 3/4	49	58 1/2	49 1/2	76 1/2	49 1/2	102 1/2	29 1/2	40	29 3/8	43 3/8	21	28 1/2
Unmanured ..	22 5/8	32 3/4	17 3/8	26 5/8	17 1/4	26 7/8	17 5/8	33 1/2	17 7/8	39 7/8	25 1/5	31 1/2	23 1/2	28 1/4	17 1/2	21
Castor-cake, 6 maunds ...	34 1/4	42 3/4	34 7/8	52 5/8	35 1/6	55 1/2	35 3/4	57 1/2	37	75	30 1/2	42 1/2	30 4/5	43	23 1/4	29
Cowdung, 50 maunds ...	39 3/4	45 3/4	34 3/4	45 1/2	34 7/8	52 1/3	35 1/6	55 1/3	36 7/8	74 1/2	34 3/4	46 1/2	31 1/8	47 1/2	23	28 1/2
Unmanured ...	18 3/4	26 5/8	18	27 3/4	17 3/4	28	18 1/6	28 1/3	18 1/8	36 3/8	23 3/4	36 1/4	21 3/4	34 7/8	17 7/8	22 3/4
Bonemeal, 3 maunds ...	37 1/3	48 1/4	48	60 3/4	47	55 7/8	47 1/2	58 1/2	48 1/5	96	27 7/8	35 3/4	28 1/8	34 7/8	23 1/2	29
Bonemeal, 6 maunds ...	39 3/4	46 1/4	50 7/8	62 1/6	15 1/8	63 3/4	51	65	51 3/8	103 1/2	31	40	30 1/8	41 1/8	23 1/8	28
Unmanured ...	19	26 1/2	17 1/2	29 3/4	18 3/4	30 1/2	19 1/6	30 3/4	19 3/8	40	30 1/4	41 1/5	28 3/4	34 3/4	18 1/5	21
Bonemeal, 3 maunds ... Saltpetre, 30 seers ...	43 5/8	48 1/3	57 1/2	72 5/8	57	74 7/8	57 1/2	75 1/6	53 3/4	108	36 5/8	55 5/8	38 5/8	55 5/8	24 1/2	31 1/2

The most striking feature about this table is the poor returns since 1903. In 1904 there was a decrease in outturn of 30 per cent. due to drought at flowering time in October. In 1905 there was again a decrease of 30 per cent. due to late transplanting owing to the July flood. In 1906 there was a decrease of 50 per cent. due to late transplanting owing to the June drought and the inability of the canal authorities to supply water in July.

Manure Experiments.

Second Series.—Manures analysed before application.

The scheme is to apply 50lbs. of nitrogen per acre in various forms, except in the case of bonemeal which is taken to supply 30lbs. of nitrogen only. Previously the amount of manure was calculated according to a standard composition of each, but since 1901-02 each manure has been analysed separately and the amount calculated accordingly. The following manures were tested: cowdung, bonemeal, bonemeal plus saltpetre, saltpetre alone and castor-cake. To supply the requisite amount of nitrogen the following quantities of manure were required, *viz.*:—142½ maunds of cowdung, 14⅜ maunds of bonemeal. 14⅜ maunds of bonemeal plus 2⅝ maunds saltpetre.

The following table gives the average outturn for the past ten years:—

	Average yield per acre in maunds (80lbs.) Grain.	Straw.
Cowdung, 142½ maunds	34⅕	66
Unmanured	26⅓	48⅖
Bonemeal, 14⅜ maunds ... ... Saltpetre, 2⅝ maunds	37	68½ (The average of 3 plots.)
Bonemeal, 14⅜ maunds	40	73¾
Saltpetre, 6¼ maunds	31¾	61½
Castor-cake, 10½ maunds	33½	61¼

The results are striking. In each case the manure gives an increase, but in no case is the extra increase commensurate with the amount of manure applied. So much manure has been applied that the unmanured plot is the most economical plot in

the series. The results corroborate those of series I, *viz.*, that (1) 3 maunds of bonemeal and 30 seers of saltpetre per acre, and (2) 50 maunds of cowdung per acre are the most economical manures to be given to the paddy crop for such a soil. Hence $142\frac{1}{2}$ maunds of cowdung or $14\frac{3}{8}$ maunds bonemeal plus $2\frac{5}{8}$ maunds saltpetre or $14\frac{3}{8}$ maunds bonemeal by itself or $6\frac{1}{4}$ maunds saltpetre or $10\frac{1}{2}$ maunds of castor-cake are too large quantities to be applied per acre as manure for paddy to such a soil. In other words, the net result of both series of experiments is that the paddy crop does not require so much manure as will supply 50lbs. of nitrogen as cowdung, bonemeal, saltpetre, bonemeal and saltpetre or castor-cake, but that from an economical standpoint about one-third of that amount or about 17lbs. of nitrogen per acre in the form of cowdung or bonemeal plus saltpetre is quite sufficient.

Seventeen pounds of nitrogen in cowdung and bonemeal plus saltpetre is represented approximately by 50 maunds of cowdung and 3 maunds, bonemeal plus 30 seers of saltpetre per acre, respectively.

Third Series. Green manuring.—San hemp and dhaincha, two leguminous crops, and jute, a non-leguminous crop, were green manured and compared with (1) 50 maunds of cowdung, and (2) an unmanured plot.

The following statement gives the average returns for jute, cowdung and unmanured plots for eleven years, san hemp for five years and dhaincha for four years :—

	Yield per acre in maunds (80lbs.) Grain.	Straw.
Jute (green manured)	30	45
Cowdung	$26\frac{1}{2}$	$40\frac{1}{2}$
Unmanured	$16\frac{1}{3}$	28
San hemp (green manured)	23	$37\frac{1}{2}$
Dhaincha (green manured)	28	47

The piece of land on which this experiment has been carried out is very poor and this possibly accounts for the small outturn from the cowdung plot. The figures demonstrate forcibly that green manuring is a very economical method in the cultivation

of paddy. This should be especially remembered by those people who cannot obtain other manures. Jute (average of eleven years) ploughed in gives an increase of 14 maunds of grain plus 17 maunds of straw, while dhaincha (average of four years) gives an increase of 12 maunds of grain plus 19 maunds of straw. Jute, dhaincha and san hemp are sown in the end of May and ploughed under in July. The only extra cost of green manuring is the price of the seed which is very small, and two extra ploughings with one laddering to cover the crop properly.

B.—Variety Experiment.

Very little experimental work has been done on the subject of varieties of paddy. Their name is legion. To all those interested I would call attention to the late Mr. N. G. Mukherji's Catalogue of Exhibits of the Bengal Agricultural Department at the recent Indian Industrial and Agricultural Exhibition, 1906-07, from which an idea will be obtained of the vastness of the subject. He collected 1,182 named varieties for that occasion.

Out of all this chaos of kinds and varieties we are trying to get at something definite—at certain varieties that we can recommend to the cultivator as approved varieties.

The cultivator knows best what he wants to eat and he can be allowed to choose his own pet variety according as his appetite decides, but for market purposes there are certain varieties that always command higher prices and readier sale than others. We have tested eight of these varieties, *viz.* :—

Badshabhog	(Bengal)	fine grained.
Kataribhog	do.	do.
Dadkhani	do.	do.
Banktulsi	do.	do.
Balam	do.	do.
Patna	do.	medium fine grained.
Sukhavel	(Bombay)	fine grained.
Kamod	do.	do.

They have all given fair results. Dadkhani has given consistent good results during the past five years and is well

worthy of notice. Kamod did excellently the first year but fell off a little every year afterwards.

C.—METHODS OF CULTIVATION EXPERIMENTS.

(1) Implements :—

(*a*) Sibpur plough *vs.* Local plough.
(*b*) Surat Bakhar *vs.* Local plough.

(*a*) *Sibpur plough* vs. *Local plough.*

This experiment to compare the Sibpur plough with the local plough was commenced in 1894 and carried out for ten years. Except for the ploughs the same treatment was given throughout. The experiment was carried out in triplicate, each plot receiving a different manure. The following table gives the average yields of three plots for ten years :—

	Yields in maunds of 80lbs. Grain	Straw.
Local plough	... $25\frac{2}{3}$	49
Sibpur plough	... $28\frac{1}{2}$	$52\frac{1}{2}$

Hence the Sibpur plough gave a better outturn by 3 maunds of grain plus $3\frac{1}{2}$ maunds of straw than the local plough.

(*b*) *Surat Bakhar* vs. *Local Plough.*

For the past three years these two implements have been compared in the preparation of the paddy transplanting bed and results are in favour of the local plough.

(2) Sowing experiments :—

(*a*) Quantity of seed in broadcast cultivation.
(*b*) Spacing in transplanting.
(*c*) Numbers of seedlings per hole in transplanting.

(*a*) *Quantity of seed in broadcast cultivation.*

Seed was sown broadcast on the land as is the custom in some districts and three different seed rates were compared, *viz.*, 60lbs., 30lbs. and 20lbs. per acre. Cowdung to supply 50lbs.

of nitrogen per acre was applied. The land was ploughed six times and laddered once. Seed of fine grained paddy *Badshabhog* was sown broadcast in the above quantities and the after-treatment consisted of two weedings. The following table gives the results of the last three years :—

Quantity of seed sown broadcast per acre.	Outturn per acre, 1904.		Outturn per acre, 1905.		Outturn per acre, 1906.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
	Mds.	Mds.	Mds.	Mds.	Mds.	Mds.
60 lbs. per acre	34·1	54·9	35·5	58·5	10·2	20·4
30 ,, ,, ...	28·3	51·3	36·5	52·1	17·2	20·4
20 ,, ,, ...	32·7	51·3	34·4	56·1	17·5	20·4

The results show that there is no need to sow more than 30lbs. of seed per acre, in the broadcast cultivation of paddy.

(b) *Spacing in transplanting of seedlings.*

Seedlings transplanted 9″, 12″, 15″ and 18″ apart were compared. Cowdung at the rate of 100 mds. per acre was applied. Seed time, transplantation, fore and after treatment of the crop are the same as that described in the manure experiment. The same number of seedlings was transplanted in each hole.

The following are the results for 1904, 1905 and 1906 :—

Degree of spacing in inches each way.	Outturn per acre, 1904.		Outturn per acre, 1905.		Outturn per acre, 1906.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
	Mds.	Mds.	Mds.	Mds.	Mds.	Mds.
Seedlings transplanted 9″ apart	28·8	57·0	29·7	45·5	22·6	28·1
,, ,, 12″ ,,	30·9	43·1	28·4	41·4	23·4	28·1
,, ,, 15″ ,,	28·6	52·0	28·3	50·5	21·0	25·6
,, ,, 18″ ,,	26·9	32·0	24·2	36·8	18·7	20·4

The results show that 9″ to 12″ is the best distance apart to transplant paddy seedlings.

(c) *Different numbers of seedlings per hole in transplantation.*

One, two and four seedlings per hole were compared. The distance apart of 12″ was taken. Treatment, fore and after

cultivation were exactly like the preceding experiment (2). Below are given the results for the past three years—

Number of seedlings per hole and distance apart each way.	Outturn per maund.					
	1904.		1905.		1906.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
1. One seedling per hole 12″ apart	34·8	48·2	28·1	38.9	13	22
2. Two seedlings ,, 12″ ,,	30·7	42·4	23·0	37·3	13	18
3. Four ,, ,, 12″ ,,	26·0	36·5	30·0	45·0	13·5	18

The results demonstrate that there is no need to transplant more than one seedling per hole.

D.—Jute in Rotation with Aman Paddy.

This experiment of taking off a crop of jute from the land before transplanting the paddy was commenced in 1905. Jute was sown in the beginning of May and harvested in the beginning of August, while the paddy was transplanted in the third week of August and harvested in December. To prepare the jute seed-bed, eight ploughings and three ladderings were necessary while the crop was raked (bidared) thrice, thinned once and weeded twice. After jute harvest the land was ploughed thrice and laddered (harrowed) once to prepare the transplanting bed for paddy, while the after cultivation of the paddy crop consisted of one weeding, one hoeing and one watering.

In 1905, $15\frac{1}{2}$ mds. of grain plus $19\frac{1}{2}$ mds. of straw (fine variety) was obtained, while in 1906, 18 mds. grain plus 22 mds. of straw (coarse variety) was obtained :

Crops.	1905.		1906.	
	Yield per acre in maunds.		Yield per acre in maunds.	
	Grain.	Fibre or straw.	Grain.	Fibre or straw.
Jute	.. ..	16	18	$17\frac{2}{5}$
Paddy (coarse)	$15\frac{7}{10}$	$19\frac{2}{5}$		22
Jute	......	......	$12\frac{4}{5}$	$17\frac{3}{5}$
Paddy (fine)	...	.....		19

In 1905 meteorological conditions were not favourable to a good paddy crop. In July the abnormal amount of 37·32″ of

rain was recorded, in contrast to an average of 12·32″ for the district, while 3″ more than the normal rainfall was recorded in August and September. This caused very unfavourable growing conditions for the paddy crop before September. A yield of 16 mds. of jute followed by an outturn of $15\frac{7}{10}$ mds. of paddy grain plus $19\frac{3}{5}$ mds. of straw is, therefore, very reassuring.

In 1906 no rain fell in April, and as the canal was unable to supply water, the jute sowing was three weeks late. Hence the jute harvest was retarded and the growing period of the paddy crop was shortened by three weeks. The return of $17\frac{2}{5}$ maunds of jute followed by 18 mds. of grain plus 22 mds. of straw from a coarse variety of paddy, and $12\frac{4}{5}$ mds. of grain plus 19 mds. of straw from a fine variety of paddy are very satisfactory.

The following table gives full details of the experiment in both years :—

Crop.	Quantity of manure applied per acre.	Date of planting.	Date of harvesting.	Outturn per acre in maunds.	
				Grain.	Straw or fibre.
1905.					
Jute ...	Cowdung, 5 tons	1st May 1905 ...	20th July 1905	...	16
Paddy (coarse) ...	No manure ...	3rd Aug. ,, ...	4th Dec. ,,	$15\frac{7}{10}$	$19\frac{3}{5}$
1906.					
Jute ...	Unmanured ...	10th May 1906	3rd Aug. 1906	...	$17\frac{2}{5}$
Paddy (coarse) ...	Saltpetre, 30 seers.	18th Aug. ,,	5th Dec. ,,	18	22
1906.					
Jute ...	Unmanured ..	10th May 1906	3rd Aug. 1906	...	$17\frac{3}{5}$
Paddy (fine) ...	Saltpetre, 30 seers.	18th Aug. ,,	5th Dec. ,,	$12\frac{4}{5}$	19

1905.—In this year, $\frac{1}{10}$ acre plots were taken. These plots had for the previous five years only grown jute each year. Cowdung at the rate of 5 tons per acre was applied to the land before the last ploughing in the preparation of the jute seed-bed, and the paddy crop received no manure.

1906.—In 1906, four $\frac{1}{2}$ acre plots were taken on land that had previously grown sugar-cane. No manure was applied to the land for the jute crop, but the paddy crop was top-dressed with 30 seers of saltpetre per acre.

The following statement shows the economic result of the experiment in 1906:—

Crop.	Yield per acre.		Cost of cultivation.	Money value of outturn.	Profit.	
	Grain.	Fibre or straw.			Per acre, each crop.	Total. per acre.
	Mds.	Mds.	Rs. A.	Rs. A.	Rs. A.	Rs. A.
Jute	...	$17\frac{2}{5}$	52 6	179 7	127 1	...
Coarse Paddy	18	22	35 1	57 3	22 2	149 2
Average of 79, 80 and 81, 3 plots. Jute ...	...	$17\frac{3}{5}$	56 13	180 12	123 15	...
Average of 79, 80 and 81, 3 plots. Fine Paddy ..	$12\frac{4}{5}$	19	36 0	64 13	28 13	152 12

These figures do away entirely with the idea that if the area of jute cultivation is increased, the people's food-supply will be imperilled, for not only is the raiyat's food-supply assured by the paddy crop, but in the same year a crop of jute is obtained from the same land and this extra crop will enable the cultivator to obtain other necessities of life than those ensured by the paddy crop. A net profit of Rs. 150 per acre is well worthy of a farmer's consideration.

In connection with this experiment and since the above figures were published, I have received the following interesting information. N. D. Beatson Bell, Esq., I.C.S., C.I.E., Director of Land Records, Eastern Bengal and Assam, writes:—"The following figures are taken from the Settlement Records in a few Estates in the Rungpur District:—

Name of Estates.	Area in acres under jute.	Area in which jute was followed by			No crops.
		Winter rice.	Other food crops.	Non-food crops.	
		Acres.	Acres.	Acres.	Acres.
Panga ...	2,873	1,165	373	6	1,329
Kaya ..	2,493	1,142	938	...	413
Chatnai ..	1,444	757	283	..	404
Total ...	6,810	3,064	1,594	6	2,146

The above figures denote that in these estates 45 per cent. of the land that grows jute grows also a crop of paddy the same year.

These figures demonstrate without a doubt the practicability of the above experiment.

I would only add the following advice to cultivators in the Burdwan Division before finishing, *viz.*:—"If you want a good crop of paddy, get your jute sown as early as possible so that the crop may be cut early enough to allow of the transplanting of paddy in July and give a good dressing of manure to the jute crop as well as a top-dressing of soluble manure to the paddy crop."

THE IMPROVEMENT OF COTTON IN SIND

By T. F. MAIN, B.SC., F.H.A.S.,

Assistant Inspector-General of Agriculture in India.

THE experiments with this object in view may be said to date from 1846 when Major Golding, then Collector of Shikarpur, tried Sea Island in the Rohri Districts. The results obtained by that gentleman were not encouraging, for the produce obtained amounted to only $18\frac{1}{2}$ seers of seed cotton per acre. Subsequently, experiments were made from time to time by officers of the Revenue Department as well as by the Forest authorities.

In 1852 Sir Bartle Frere who was Commissioner in Sind at that time came to the conclusion that no definite or useful results were likely to be obtained from such experiments, and he suggested that some practical and intelligent man should be appointed to devote himself actively and entirely to this object. Accordingly an American cotton planter, Mr. T. G. Prince, who had been engaged in cotton cultivation at Coimbatore, was appointed to superintend cotton experiments in Sind. Mr. Prince on his arrival in Sind made a tour through the Province and observed in his report "the plants I saw, both Egyptian and New Orleans, had with very few exceptions grown luxuriantly in every part of the country where only an ordinary degree of care had been bestowed, but only the New Orleans had yielded cotton." Mr. Prince held his appointment for three years till 1855 when he died. He appears to have been singularly unfortunate in his work, for it is reported that his attempts to grow Egyptian cotton in Sind were an unbroken record of failure, and from one cause or another there was not a single instance

of success. After this Sir Bartle Frere abolished the experimental establishment and no further efforts in this direction were made until 1860, when the Bombay Chamber of Commerce, by the direction of the Manchester Cotton Supply Association, forwarded five bags of Egyptian cotton seed to the Commissioner in Sind for experimental cultivation in the Province.

Of the experiments with this seed the most successful result was obtained at Rattadera in Larkhana, where the produce amounted to 480lbs. of seed cotton per acre. None of the trials made in other parts of the Province appear to have resulted in the production of any cotton at all and even in the Rattadera case, there was some doubt whether the cotton was really the produce of Egyptian plants for the staple was extremely short. This cotton was valued by the Bombay Chamber of Commerce at from $5\frac{1}{4}d.$ to $5\frac{3}{8}d.$, whilst at the same time middling Egyptian was worth $8\frac{1}{4}d.$ per pound. Little more was done during the succeeding years, but there was a revival of interest in this question about 1867.

Mr. Hughes, Cotton Inspector in Sind, initiated some experiments in 1868 at the Malir Farm, and these were continued by Mr. Strachan the following year. About this time a Model Farm was started at a place called Salura near Hala in the Hyderabad District, and Mr. Strachan transferred his experiments to this place in 1870. The farm was situated in one of the best cotton growing tracts in Sind and experiments were carried on more or less continuously till 1879 when Mr. Strachan was transferred to Hyderabad. The experiments were continued in the Economic Garden of Hyderabad till 1889. During all these years Mr. Strachan experimented with a great number of varieties of cotton, of which the following list is a record :—

List of Cotton Varieties.

Peruvian, Egyptian, Bourbon, Hinganghat, Dharwar, Nankin, Sea Island, American, Broach, Baburich, Dharwar-American and Sind (Indigenous).

The best results were obtained with American (New Orleans) and Nankin, but even from these the returns obtained were not equal to the yield of Sindhi cotton.

The report of these experiments shows that the yield obtained per acre was very low.

In 1869-70 the yield of Egyptian cotton was only 80lbs. of seed cotton. It was further remarked in 1870-71 that the Egyptian variety seemed to suffer from very slight variation in the weather and eventually succumbed to the frosts of January.

In the year 1871-72 experiments were conducted in growing Egyptian and other varieties of cotton on ridges, but the conclusions come to were : " Egyptian turned out badly although up to the time of harvest the plants were as good as any one could wish them to be ; they also flowered well and set plenty of bolls which, however, were badly attacked by boll-worms and then by a small bug-like fly which also took possession of any healthy bolls and discoloured the cotton slightly."

Further experiments in ridge planting were made in 1873-74, but the yield was practically nil, and Mr. Strachan in his remarks states, " of the two methods of planting the plants succeed best when sown in lines on the flat." Again Mr. Strachan in summarising his opinion upon the subject of introducing Egyptian cotton into Sind, says, " I am sorry that neither the reports of experiments made in this line before I had seen India nor the experience I gained during the nearly 21 years I was employed in trying to introduce new kinds of cotton or improve the Native variety, permit me to offer even the shadow of a hope that the Egyptian variety of cotton will be successfully grown as a crop that will pay in this Province. I was, when I first took these experiments in hand, very hopeful of succeeding with the Egyptian variety, but failure year after year led me to question the correctness of what I had heard and read about the soil and climate of Egypt and Sind being so much the same and that it was an almost certain thing the Egyptian would be just the very plant to suit both its soils and climate. That the Egyptian plant and the soil of Sind suit each other, I still believe. It

is in my opinion the climate which stands in the way of success and forms an unsurmountable barrier to any undertaking in the way of growing it in this Province. The climate of Egypt must differ considerably from that of Sind, it is bounded on two sides by salt water, while very little of Sind touches the Sea and that portion of it which does so is but little suited for cotton growing. In describing the climate of Egypt, Samuel Smith in a letter on the cotton trade of Egypt published in 1883 says of its climate, 'for eight months of the year it is cool and delightful and the summer months far from unhealthy. It has indeed one of the most salubrious climates in the world.' My experience of the climate of Sind would lead me to give it a rather different character, and I may add that I doubt whether any of the chief cotton growing districts in India can justly claim a description of climate similar to that just quoted. At any rate if the Egyptian cotton plant will succeed only in such a climate, Sind is not the place for it, though its climate be not the worse possible one could select to grow cotton or live in."

Again Mr. Strachan remarks that the flowers are usually numerous and healthy and the pods show no symptom of ill-health till a little before the time when they should begin to open, then they begin to shrivel and fall to the ground and the few capsules which do give cotton are seldom healthy looking. The only place in Sind where Mr. Strachan thought Egyptian cotton might succeed was the Shahbander or Tatta District of Lower Sind, where the land is good and the sea breeze is felt.

More recently experiments were carried out on the Municipal Sewage Farm at Karachi at the request of Mr. Jamsetjee N. Tata, of Bombay, who revived the interest in this question by a memorandum on the growth of Egyptian cotton in India, which he published some ten years ago. In this memo. Mr. Tata strongly urged further experiments and in response to his request a trial was started on the Sewage Farm at Karachi in 1896. Mr. Tata suggested that the Egyptian cotton should be tried as a *rabi* crop because climatic conditions during the eight months from October to May in Sind corresponded closely to

those prevalent in Egypt, from March to October, the period when cotton is grown in that country. Mr. Strachan, who was in charge of the farm and who was still experimenting with different varieties of cotton, conducted the experiment, but I have no information as to the results. However, it may be pretty safely assumed that the experiments were not attended with success, for in that case more would have been heard of the enterprise.

Some six years ago Messrs. Ralli Brothers drew the attention of the Commissioner in Sind to the fact that the best cotton produced in that Province strongly resembled Assam and Comilla cotton, but was inferior to these. Comilla cotton possesses a short staple and a rough harsh lint and is in considerable demand on the continent of Europe for mixing with wool in the manufacture of certain kinds of cloth.

The idea, therefore, occurred to Messrs. Ralli Brothers that the cultivation of this class of cotton would be of mutual advantage both to the cultivator and the exporter, for Comilla cotton commands a price of Re. 1-8-0 per maund above that of the indigenous Sind variety.

With the co-operation of the Commissioner in Sind arrangements were made for the experimental cultivation of this cotton and the first consignment of seed arrived in time to be sown in the *kharif* of 1900. The experiments were conducted by the Revenue officers at Mirpurkhas, Umerkot, Sinjhero, Khipro, Hala and Shahadadpur, but unfortunately little success rewarded these efforts. Renewed trials were made the following year, but with perhaps one exception no success was obtained. Many explanations were advanced to account for these failures. In some cases the seed did not germinate, in others the land was said to be bad, while yet in others the blame was laid upon the injuries done by insects and hot winds. In the case of Mirpurkhas the Mukhtyarkar sowed 2½ acres with Comilla seed and obtained 7 maunds 7 seers of seed cotton. This was a small yield, but there were several causes to explain it. The seed was sown very late on sandy land possessing much *kallar*. Insects did considerable damage and

many *phutties* failed to mature owing to the late period at which the seed was sown.

Messrs. Ralli Brothers expressed the opinion that the cotton grown in 1900 showed very satisfactory quality, the *phutties* being of unusually large size and the cotton being white and rough. In 1902 the same firm considered the Comilla much the better of the two varieties tried, but they were dissatisfied with the colour of the lint which left much to be desired in the matter of whiteness. It was considered that this defect was due to old seed having been sown.

In 1903 Mr. MacKenzie, Deputy Commissioner of Thar and Parkar, imported 100 maunds of Comilla seed and distributed it along with the seed produced by the previous year's crop among the Zamindars of his district. He also sowed some himself at Mirpurkhas. Unfortunately heavy rain, when the plants were at a tender age, did great damage. The Mukhtyarkar resowed the land partly with the previous year's seed and partly with new seed. This, of course, spoiled the experiment, for one of the chief objects was to ascertain whether the quality of the lint deteriorated when grown in Sind. Moreover, the new seed proved very unsatisfactory, producing very small *phutties* and quite unlike those obtained in previous years. This led Mr. MacKenzie to the conclusion that either wrong seed had been supplied or, if not, then the seed must have been very bad. No further attempts were made to introduce this variety.

It will thus be gathered from the above remarks that up to the year 1903 no success had rewarded the many efforts which had been made with the object of improving the cotton of Sind. However, in December of that year Mr. Fletcher, who had recently taken up the duties of Deputy Director of Agriculture in the Presidency of Bombay, made a tour through this Province, and was much struck by the great similarity of the conditions of the country to those prevailing in Egypt. Unlike Mr. Strachan, Mr. Fletcher possessed personal knowledge of Egypt and its agricultural practices, and he at once saw the great possibilities which might follow upon carefully conducted experiments with

Egyptian cotton. Mr. Fletcher was confirmed in this opinion when on a visit to the Deputy Commissioner of Thar and Parkar, he noticed some Egyptian plants growing luxuriantly in that gentleman's garden.

Accordingly experiments were set on foot first at Dhoro Naro and afterwards at Mirpurkhas. Very satisfactory results were obtained and in the following year seed was distributed to the Zamindars on the Jamrao Canal sufficient to sow 1,500 acres. Agriculturally the cotton proved a great success, but unfortunately the prices obtained fell far below expectations. This, however, may be ascribed purely to the fact that hitherto there had been no supply of this class of cotton and consequently no appreciation and no demand.

Arrangements were made for 6,000 acres to be put under this crop in the current year, and the Government of Bombay have voted Rs. 5,000 and made special arrangements to secure a satisfactory market for the produce. Thus, after 60 years of experiment and trial the object aimed at seems at last to have been attained. It yet remains, however, to be proved whether the quality of the lint will maintain its high character in the cotton markets of the world.

PRACTICAL REMEDIES FOR INSECT PESTS.

By H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,

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The ultimate aim of the study of destructive insects is the discovery of some feasible method, whereby their increase and destructiveness may be checked and crops preserved from their attacks. In such a quest, not only must the habits and characteristics of each individual pest be considered, but it is of equal importance to take into account the conditions under which the crop is grown and the facilities there are for adopting any method of repression. It is probable that in India, the scientific methods that appeal to the skilled farmer of European countries will be of little value when applied to the conditions of Indian Agriculture and the best methods that science reveals can scarcely be regarded as suitable to the present problem. In very many cases, the habits of a pest are such that practically nothing is possible unless we can utilise the most up-to-date and artificial methods. In others, a weak point can be found in the life of the pest when it can be successfully attacked by some very simple means. Given some such simple remedy, thorough co-operation in its application over some area is usually also necessary, and this is perhaps to be obtained only when an unusual abundance of a pest awakes the ryot to the necessity of some action and, with a little pressure, a fair trial can be given to the remedy. Experience has shown that, for some pests, there are such simple remedies as can be applied by an individual cultivator, and it is chiefly these I propose to discuss here.

An instance that has already been discussed in these pages (Vol. I, p. 58), is the very simple method of checking the stem-borer of cotton, where the withered plants which contain the

pest can be removed and burnt with the pest in. The emerging beetle is not a wide-ranging insect and is apt to confine its ravages to a small area; the destruction of the withered plants in a cotton plot does much to protect that particular plot, and though joint action over a large area would be far more effective, even a small plot may be largely protected.

The red bug of cotton is a pest that yields to the simplest of all methods, destruction by hand; so also the very common dusky bug, which often swarms in cotton bolls, can be checked by the simple precaution of removing all the bolls that are worthless at the same time as the round ripe bolls are plucked. It is unfortunately a general practice to leave on the plant those bolls which have been so damaged by bollworm as to be not worth plucking; the dusky bug finds there a secure breeding place where it may lay its eggs, and where its young can obtain food from the uninjured seeds; from these breeding places it spreads to other bolls and in them it sucks the seeds, rendering them useless for sowing or oil-extraction. The removal of all such bolls is a simple and effective means of preventing the feeding of this pest. In cases where dusky bug is very abundant, a further simple method is valuable; the bug collects in the bolls in great numbers and, when disturbed, runs out and falls to the ground. The greater number of these can be destroyed by tapping the boll while a pot of water with a film of kerosene over is held below the boll; practically all the bugs fall into the water and are killed, and an infested field can be very rapidly cleared.

Among the minor pests of cotton that are occasionally very injurious is the leaf roller, a green caterpillar that rolls up the leaf into a funnel and lives inside. This pest commences when the cotton (if sown with the first rain) is about a month old; the rolled up leaf is very characteristic and an infested plant has a peculiar appearance due to the unnatural position of these leaves. Every one of these leaves can be picked off with the caterpillar in and if the work is done early, the first brood can be so thoroughly checked that very little remains to be done. If the first brood is missed, the increase is so great that a vigorous crop will be

completely stripped later in the season, and it then becomes a far harder task. Were labour an expensive item, spraying with an arsenical poison would be the simple remedy, and both have been in use on the Pusa Experimental Farm. As it is, we have here a case that particularly applies to our conditions, one that is within the reach of any cultivator or zamindar.

A pest that is constantly reported from cane-growing districts is the Moth-borer; this pest was discussed in a previous number of the Journal (page 97, Vol. I, Pt. ii) and the principal remedy for it is to cut out and remove all the shoots which die in the young canes and which have the insect in them. In many juar-growing districts, especially in the Central Provinces and Bombay Presidency, this hibernates in juar and the caterpillar is constantly found in the stumps left in the ground after the crop is cut. The removal of these stumps is a very valuable remedy, since it removes the pest when it has no other refuge and destroys the insects that would otherwise do much harm later in the season. This is a practical measure well worth impressing on cultivators; they know the insect, they can be shown it in the juar stump, and though they do not understand its transformation, yet they are open to the commonsense suggestion that these insects will increase later on and attack their crop. Most of these remedies are pure commonsense, and if we could find such weak points in the life of every pest, we would be able to deal more effectively with the problem. Apart from their value as remedies, they are valuable also as demonstrations; if a start can be made by demonstrating such simple remedies, and the ryot can be induced to take them up at times when the losses from the pest are fresh in his mind, the foundation for further work in checking preventible loss will be laid. It is astounding how universally the simplest remedies are unthought of by the cultivator, apparently because the question of checking pests never suggests itself until the overwhelming numbers of a caterpillar or grasshopper make a practical remedy an impossibility. In very many cases, if the possibility of checking the insect was known to the ryot, he would, from his own intimate knowledge of his crops,

be able to prevent or check much of the loss that constantly occurs.

A case in point is the brinjal crop, a paying vegetable crop grown for long periods on land that can be irrigated, to supply a local market. This plant is destroyed by a caterpillar that tunnels in the stem and that sooner or later so interferes with the upward flow of sap that the plant suddenly withers; the cultivator then pulls up that plant and, if not too late, puts in a young one from which he may hope to get a small yield. The withered plant he lays somewhere near by, with the borer in; this presently transforms and emerges to lay eggs in large numbers on other plants. Had the cultivator burnt his plants from the very first, plucking them out regularly as they withered, he would have prevented the very large loss in the later growth of the crop, a loss that often means a great reduction in the yield of the field.

Til is a crop from which two pests are very commonly reported; one is a large green caterpillar, with bright oblique stripes on its side, and a curved horn at the hind end. It grows to a length of three inches and is very conspicuous. The other is a small caterpillar, creamy green, with little black specks, which rolls the leaf and bores in the capsules. Both yield to the same treatment, destruction by hand *when they first commence;* the smaller caterpillar especially is checked by this treatment as its life is short, it multiplies very rapidly and it often is very injurious to the seed capsules as the crop ripens. In this case again, it is cheaper and equally effective to remove by hand as to spray with an arsenical poison.

A familiar pest to cultivators in some parts of India is the common white ant; investigation up to the present shows that the destructive white ant of the plains is one species only; in some parts of the country it nests below ground, in others at the surface or it builds up mounds above the surface of the soil. Where the termites nest deeply as in the deep alluvial soils of the Gangetic and Indus plains, practical means of checking termites are difficult to find; but where they nest at the surface, a great deal can be done to check them by the systematic destruction of

the nests; the simplest method is to dig into the nest and pour in abundant boiling water; the sign of success is when the very large white queens are obtained as they are found only in the nest itself, and if these are destroyed with as many of the smaller termites as possible, the termites cannot increase until they build up a new nest and rear a fresh queen. In some parts of India, there is little reason why any termite nest should be allowed to remain and a little systematic effort by each village would keep the land practically free of this destructive insect.

Another common pest is the weevil whose grub tunnels in sweet potatoes, rendering them wholly unfit for food. We have seen fields, where a crop had been dug, covered with potatoes which were thoroughly infested and left to breed weevils, thus providing a plentiful supply of insects to infest other fields or the next crop. This might readily be avoided if these potatoes were gathered and buried in a pit under a foot of hard trodden soil. It is only pure commonsense to take such a precaution and so prevent the multiplication of the insect to attack next crop.

For some pests the bag and frame so extensively used in the destruction of the hoppers of the Bombay Locust is a practical method. The surface grasshoppers do a very large amount of damage yearly in the young crops, especially in the germinating *rabi* crops. These are flattened insects, white below, with the upper surface roughened and earthy colour; they abound in the fields and hop up as one walks along. If a wide bag on a frame is run through the field fairly rapidly, the grasshopper, as it jumps up, is caught by the bag and swept up. At the end of each run the bag is twisted up and the insects shaken into a corner and destroyed. In this way a large area can be rapidly and thoroughly cleared, either before the crop is up or while the plants are still young. The cost of a bag and frame is small, as it is all made on the spot and it should not exceed three rupees. In the case of tobacco, it is very necessary to clear the land of the grasshoppers before setting out the plants. In Pusa we dip all such seedlings in Lead Arseniate Wash and so render them

immune, but the bag, if used before the plants are set out, has the same effect.

The bag in its various forms is useful in many cases when its application is once understood, and it provides the most practical remedy against a fairly universal pest of rice, the Rice Bug. This is a slender green insect, which flies readily when full grown; it emits the usual aromatic odour of its class and an infested field may often be known by that alone. As the rice comes into ear, the bugs assemble there and suck out the milky juice in the developing grain. The grain then whitens and the ear has nothing in when it comes to harvest. A light bag, 8 feet wide, run rapidly through the field, brushing the tops of the rice sweeps up these bugs and though some escape, the bulk are captured. A bag must be used as the insects escape from a plain cloth or *dhotie* unless it is smeared with sticky matter; the bag is considerably more effective if first soaked in kerosene or in an emulsion made by shaking up kerosene with sour milk. This method like the others mentioned above is in application on the Pusa Farm, where ordinary coolie labour is employed: as soon as the bug is found, the bag is used and there is no difficulty in checking this pest.

Rice is constantly attacked by another class of pest, which yields to simple treatment if that treatment is carried out over any area larger than a few acres; this pest is the stem-borer, a caterpillar which eats up the centre of the growing shoot of rice and kills it; the result is that each shoot withers, and as a single caterpillar in many cases attacks several shoots, the damage to the ripening crop is considerable. This form of damage is reported from practically every rice-growing tract in India; several insects are concerned, which are all quick breeders, and of which two or three broods complete their life-history in one crop; for all these there is but one practical cure; that is, to pick them all out from the beginning; if the cultivator would learn that withered rice shoots contain a caterpillar which, if left alone, breeds and multiplies quite naturally, he might systematically pick out and burn all withered shoots; these are

sufficiently easy to see and it does not require much time or labour to go over some acres of paddy. Were this known to the cultivator and were he to do it, we believe that no cases of destruction by these pests would ever be seen. In some cases, it is possible also to utilize another method, depending upon the fact that, like the moth-borer of cane, the stem-borer of rice spends the cold weather or hot weather when the crop is not growing in the stubble; where this stubble can be taken out and destroyed, it destroys those insects which live over until the next crop and then emerge to breed. How far the destruction of rice stubble is possible depends upon local conditions, but it is always a valuable safeguard.

A common and widespread pest is the surface caterpillar, a dark-coloured smooth caterpillar, over one inch long, which lives by day in the soil, emerging at night to wander about and cut off young plants for its food. This insect can be easily collected by hand, its burrows being revealed by the green leaves which it has consumed; as a rule, it lies hidden near the plant it has cut off, often at its base, and it is readily found with the hand hoe (kurpi).

It is perhaps needless to multiply instances of this, the simplest of all methods. For very many pests, the remedy is there to hand, namely, to destroy the insects when they first appear and so to save the later destruction caused by their natural increase. We have cited cases enough to show that, in very many instances, there are simple methods by which the cultivator could materially lessen the losses caused to his crop by insects. It is perhaps needless to say that there are other cases where equally simple remedies could be devised *by the cultivator*, if he knew how his pests lived and multiplied; in most cases, the scientific study of an injurious insect shows what its weak points are, but to take advantage of them requires also a very thorough knowledge of local agriculture which no one person can have for more than a limited area; the treatment of such pests must be a matter for the future, but there seems to be no reason why efforts should not now be made to bring home to the cultivator

the facts regarding such simple pests as it is possible for him to cure, and thereby to open his mind to the realisation of the fact that, the knowledge of the pest's life-history is the first essential, and that, given that, it is often within his scope to devise some means of circumventing the enemy. The cases enumerated above are cited as being those in which there exists a simple practical remedy for a particular pest; if the cultivator can be induced to adopt one of these and so to lessen the damage to his crop in any one case, a great step forward will have been made.

THE GOVERNMENT CATTLE FARM, HISSAR, PUNJAB.

By Colonel J. W. A. MORGAN, M.R.C.V.S.,

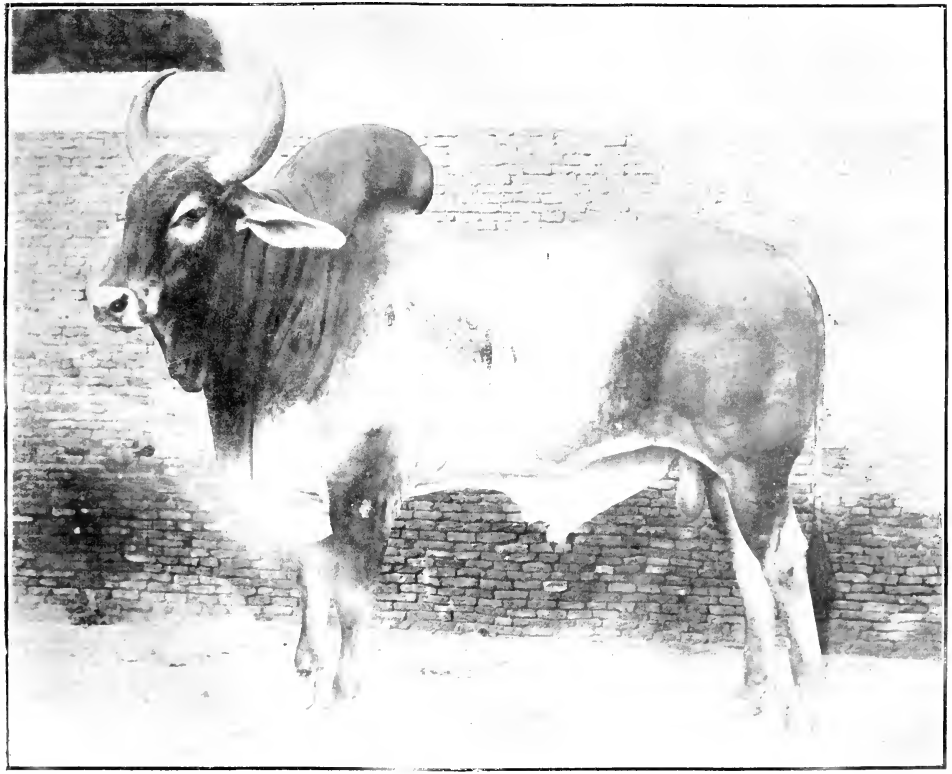
Inspector-General, Civil Veterinary Department in India.

The chief object of this article is to offer some advice regarding the breeding of some farm animals in India. I give first a short account of the Hissar Farm—the premier Cattle Farm of India—in order that those who are concerned with cattle breeding may know something of its failures and successes.

This Farm was established in 1809 for camel breeding. The breeding of cattle and horses was added in 1815. In 1853 it was decided to restrict operations to breeding bullocks for artillery and ordnance purposes, the management being transferred from the Commissariat to the Stud Department. In 1874, at the instance of the Stud Commission, it was again transferred to the Commissariat Department. Since 1898, the Civil Veterinary Department has had charge of the Farm. If a definite policy had been framed from the beginning and adhered to, the Farm would have been of much greater advantage to the country than it has been. The breeding of improved stock is a matter of years, in which it is difficult to rectify any error ; therefore, definite aims should be kept prominently in view from the start. The objects of the Hissar Farm were varied at comparatively short intervals up to recent years so that there was not time to achieve real success in any. Since the Farm was taken over by my Department, clearly defined lines of work have been laid down and followed.

The annual average rainfall at Hissar is small—considerably less than it was at one time—the grass lands are extensive, but in years of deficient rainfall they cannot be relied upon except to give very scanty grazing. Therefore, a considerable area of

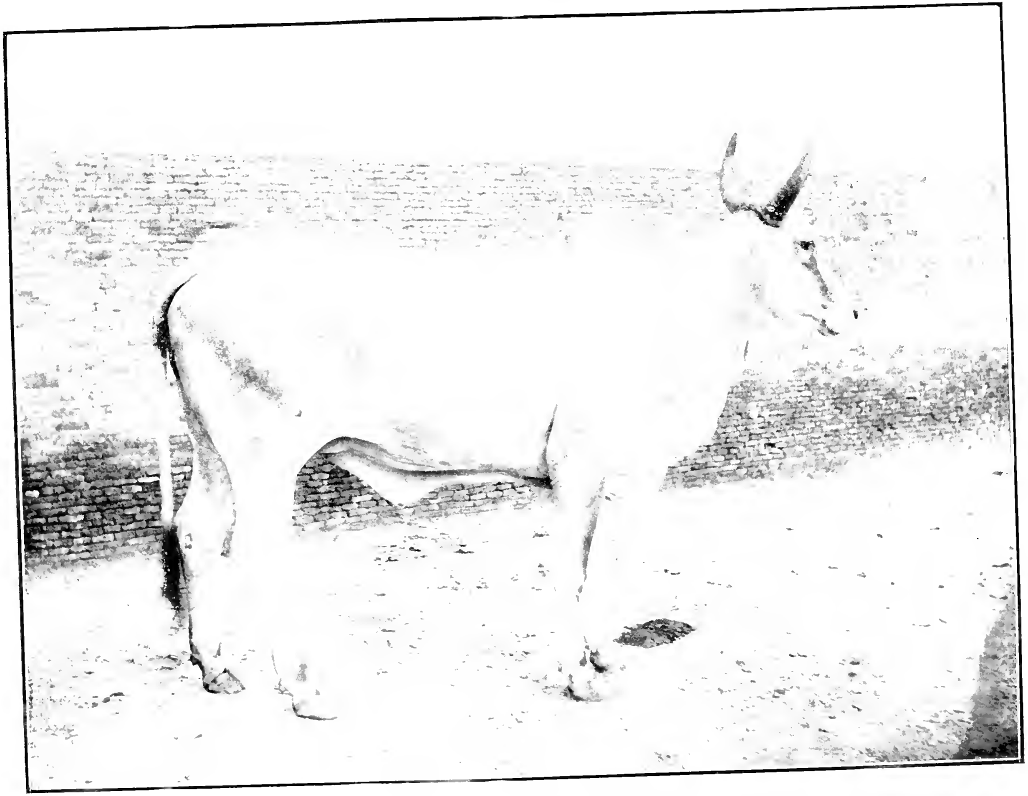
PLATE XXX



A.J.I.

HARRIANA BULL AT HISSAR FARM.

PLATE XXXI.



A.J.I.

Harriana Cow at Hissar Farm.

irrigated land is devoted to the cultivation of fodder crops. These are of various kinds but are chiefly sorghums. They yield very heavily as the arable land is naturally fertile and is heavily manured with cattle dung from the breeding herds. The fodder from the irrigated area is stored dry in stacks or as ensilage in pits.

The annual output of stock from the Farm is estimated at 250 Siege Trained Bullocks, 100 Bulls for district work, 100 Mules for ordnance purposes and 25 to 50 Donkey Stallions for mule breeding in the districts.

To meet this output, it is necessary to maintain on the Farm :—

Herd bulls	20
Breeding cows	1,500
Young stock	1,100
Donkey stallions	6
Donkey brood mares	80
Brood mares	200
Mules	400
Cultivation bullocks	250

Each kind of this list is believed to be suited to the Hissar District and many other parts of Northern India. The types will be strictly adhered to, and improved by selection. The best only will be retained on the Farm for brood purposes.

Before starting a Government Cattle Farm in any Province in India a general survey is required to determine (*a*) whether the particular district of the proposed Farm is usually free from famine and whether in ordinary years drinking-water and fodder are sufficient or abundant ; (*b*) how fodder supplies can be improved in an economical way ; (*c*) whether the best of the local cattle are true to a particular type and whether attempts at improvement are likely to succeed ; if not, whether a better breed imported from another Indian district is likely to thrive under local conditions ; (*d*) the means which should be adopted to rear and distribute bulls for the general improvement of the cattle of the district ; (*e*) the value of local fairs and shows to encourage the breeding and sale of good animals ; (*f*) whether young cattle, for work

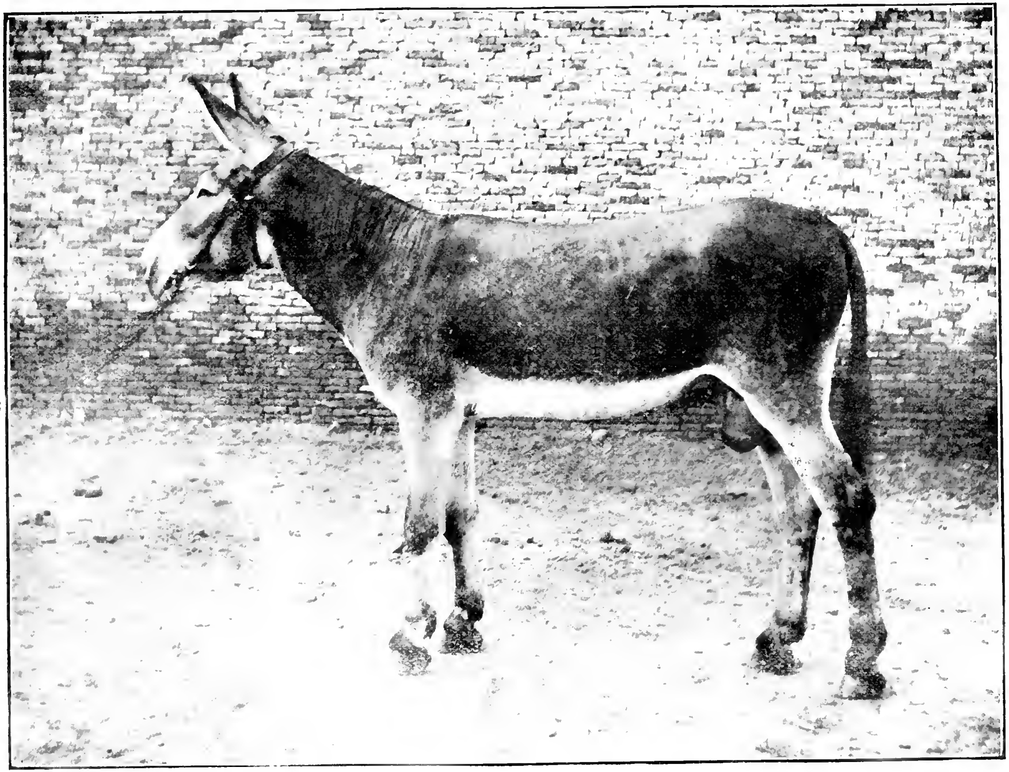
purposes, are imported into the district. If so, where do they come from and why is such importation necessary? (*g*) whether contagious or other diseases are common.

Having gathered the foregoing information, it is possible to determine whether a Government Cattle Breeding Farm can be successfully established in the particular tract or not.

Some parts of India are quite unfitted or only partially suited from climatic and other conditions for the breeding of cattle. The requirements of these parts are now met by importations from more favoured regions. In other parts of India, the cattle breeding industry is already carried on so successfully that there is no need for assistance from Government Farms. It is quite unnecessary for Government to compete with really good private enterprise in cattle breeding for the benefit of any part of India. The chief objects of a Government Cattle Farm should be the improvement of certain work and milk breeds, so that by the distribution of suitable bulls the local breeds in backward districts may be improved. The experience gained at Hissar affords a useful lesson in this and many other directions. At various times good specimens of the finest breeds of India were brought to Hissar. These importations had been reared under very varying conditions of soil, climate, etc., and at Hissar come under the influence of altogether new conditions. These breeds were crossed somewhat indiscriminately in the hope that the good qualities of both parents would be perpetuated in their offspring. Eventually the herd consisted largely of nondescript animals.

The best breeds of India—and India contains several of the very best—are largely the result of their environment, being dependent upon the local conditions or climate, pasturage, fodder from arable land, management and the like. With a transfer to entirely different surroundings, their good qualities may soon disappear. For these reasons, the improvement of cattle of a particular tract is more likely to occur by breeding from the best indigenous stock and distributing bulls so bred, rather than from the importation of even a better breed from a different part of

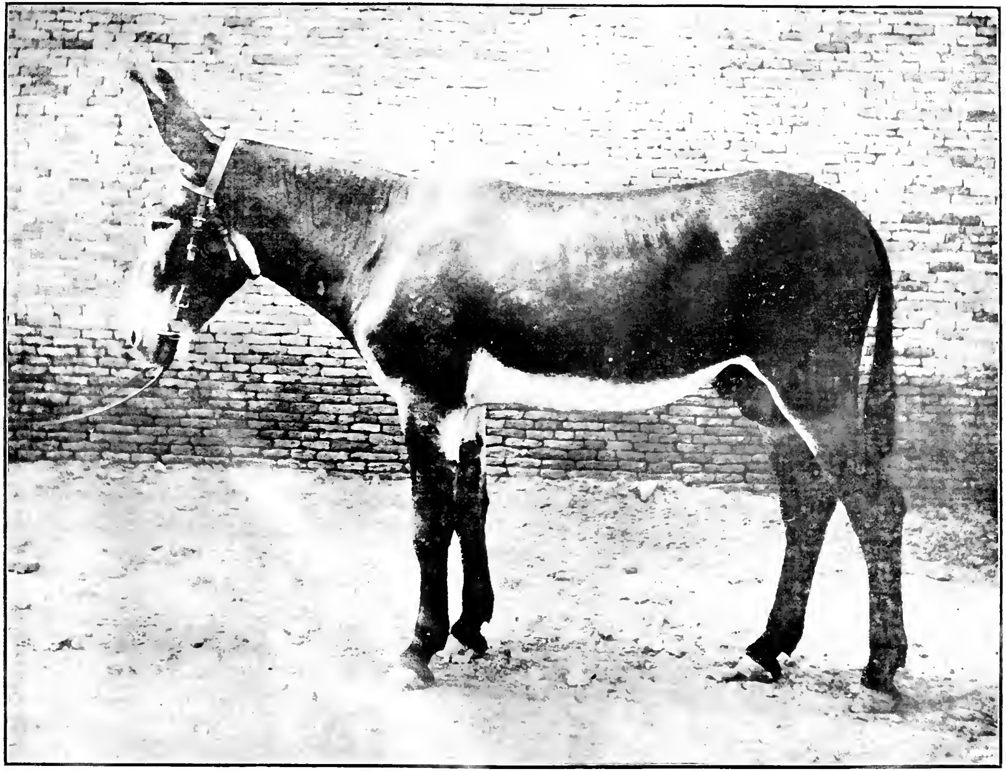
PLATE XXXII



A.J.I.

HANSI JACK.

PLATE XXXIII



A.J.I.

HISSAR JACK.

the country, where the local conditions are quite different. I strongly deprecate the advantages of crossing indigenous breeds. Crossing with foreign cattle generally leads to failure. It is probably possible to acclimatize in various parts of India superior breeds of indigenous milch cattle, but for breeding work cattle experience shows that good Indian breeds soon degenerate to the level, and even below it, of an inferior indigenous breed, unless expensive artificial feeding is arranged for.

One important object of a survey of the breeds of Indian cattle should be to determine the conditions under which they are reared and under which they can profitably be transferred for breeding and work purposes from one district to another. These conditions mainly depend upon food supplies and climate. For a Government Farm we should know definitely which is the best indigenous breed of a particular tract. The selection should be made to meet the actual requirements of the tract. It is useless to select as a type, a large, heavy, soft animal, requiring good feeding, if the conditions of the tract demand a small, active, hardy animal that can easily exist on poor feeding. The best type of animal required for local work should be most carefully selected. The object of Provincial Cattle Farms should be to produce really good bulls of correct type specially suitable for the tract referred to.

The Hissar Cattle Farm in the Punjab comprises an area of 44,000 acres, divided into (1) grazing land, (2) flow irrigation land, and (3) lift irrigation land which is leased out to tenants. The cultivated land of 2,500 acres is fenced and is irrigated from the Western Jumna Canal.

The site is thus almost an ideal one for cattle-breeding. There is essentially a large proportion of grazing land, in order to avoid the very great expense of much artificial feeding. This grazing ground gives good pasturage in years of average rainfall and is well supplied with shade trees. The large cultivated area, in years of deficient rainfall, largely supplements the natural grazing and hay by suitable fodder and grain irrigated crops. The Canal also furnishes an ample supply of good drinking-water

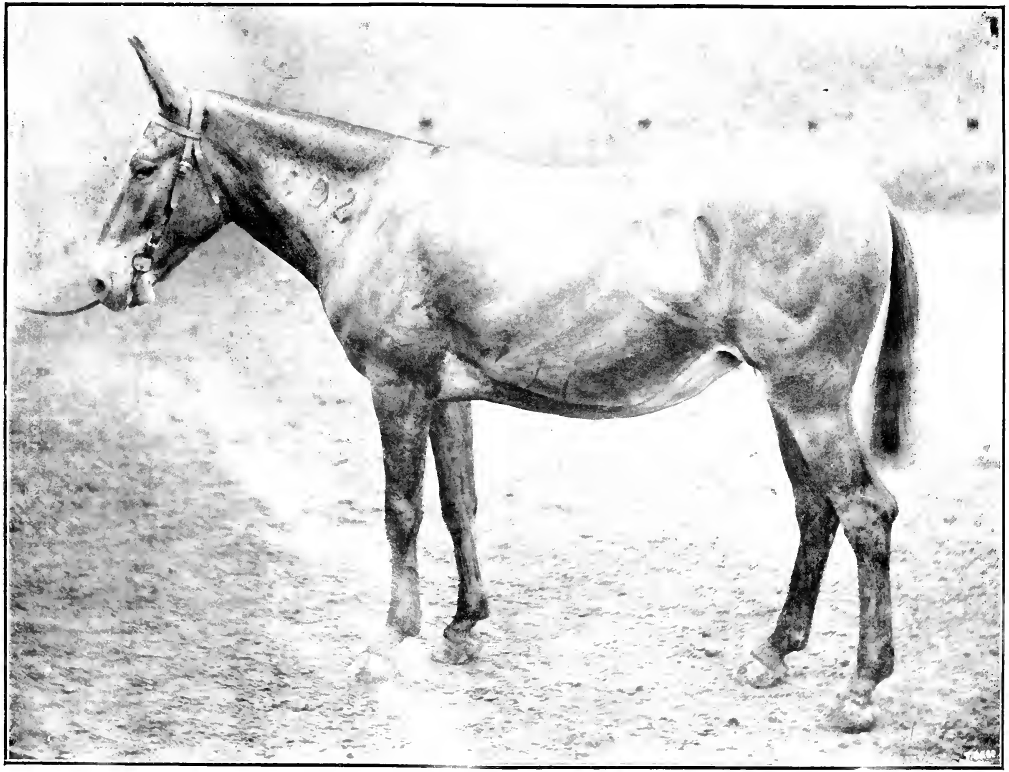
for the cattle. The experience at Hissar has been that overstocking will ruin pasture land, and that a liberal ration, particularly for young stock, is necessary to produce sturdy cattle. Quality rather than size is the chief requirement. Each breeding cow involves the maintenance of three additional animals, for young bulls must be kept for three years before distribution, whilst heifers are not ready for sale till nine months old, and have to be kept for three years before they are bred from.

One bull is generally required in India for about forty or fifty cows. Each herd should be arranged accordingly. A herd of fifty cows can be managed by one herdsman. Each herd should be grazed separately in order to regulate correct breeding. The young male and female stock must be separately herded. They should be weaned when about six months old. The cows will then breed more frequently. The breeding bull of each herd should be changed every third year in order to avoid inbreeding.

The breed of the young female stock should, when three years old, be drafted into the breeding herds to replace the old and worn-out cows. The best of the young bulls should be distributed for use in the districts when $2\frac{1}{2}$ to 3 years old. A rigid system of selection should be followed so that unsuitable young stock may be sold off as early as possible. A register showing the pedigree and other particulars regarding each animal should be maintained. It is not advisable to run a dairy in conjunction with a cattle breeding farm. In handling and milking the cows, they are liable to knock themselves about and slip their calves, whilst the loss of milk to young growing stock is not compensated by the small profits derived from the sale of milk and butter.

It is unnecessary to discuss whether bull breeding or bull rearing farms are best. The correct answer depends on particular local conditions. If promising young calves of pure breed can be purchased, some can be reared into good breeding bulls, although the percentage may be small owing to difficulty in selection among very young animals. In most parts it is impossible to obtain young calves, which are reliably pure bred, and if they are

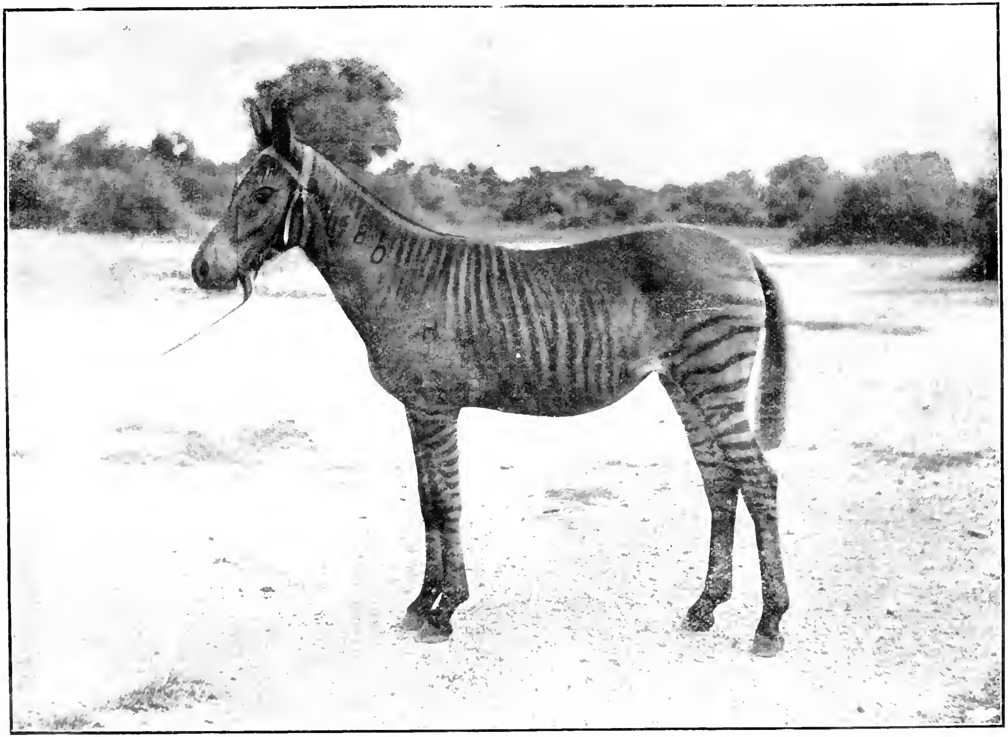
PLATE XXXIV.



A.J.I.

HISSAR MULE.

PLATE XXXV.



A.J.I.

Hissar Zebrule.

available in any number, there is no particular need for a Government Cattle Breeding Farm. In most cases it is preferable to have a bull breeding farm, where all the conditions are under control.

The famous Harriana breed is maintained at the Hissar Farm. This breed is one of the best in India. Good bulls are suitable for most districts in the Punjab and the bullocks are suitable for military and ordinary heavy draft purposes. The main characteristics of this breed are briefly described below :—

Bulls.

The chief measurements of the two best Hissar farm bulls are as follows :—

Herd bull.	Height.	Girth.	Fore arm	Shank.
	Inches.	Inches.	Inches.	Inches.
No. 1 ...	... 61	84	$14\frac{1}{4}$	$8\frac{1}{2}$
No. 2 ...	... 60	83	14	$8\frac{1}{4}$

A true bred Harriana bull is mostly grey in colour but may be black or dark blue over the neck, shoulders and flanks. The skin and hair should be soft and fine. The hump is large in size. The large dewlap hangs in folds. The chest is broad and deep and of good girth. The general frame is well rounded, but is not cumbersome. The tail should be light, short and well set on, the sheath small and close but slightly larger than European cattle. A good bull has a broad, flat back, strong loins, muscular thighs, straight flat leg bones and round, hard black feet. The horns should curve slightly upward and generally dark in colour. The forehead should be broad with the horns well apart. The head should be fairly small, not fleshy and with a clean cut muzzle. The ears are comparatively long. Hissar bulls are gentle in disposition. They are extremely active, quick walkers and the general appearance shows great quality combined with power. A typical specimen is represented in plate No. XXX.

Harriana Cows.

The cows are lighter in colour but a large majority are dark blue over the shoulders, neck and flanks. The head is light ; face

long ; horn fine and short. The body is shapely and looks light considering the length of the legs which have flat hard bones below the knees and hocks and hard small feet. The skin and hair are fine. The tail should be thin and fairly short. Many cows milk well and have large udders with teats regularly set. The milk yield from the best cows varies from 6 to 12 seers per day. Both cows and bulls show a well-bred active appearance. See Plate XXXI. The chief measurements of good cows on the Hissar Farm are as under :—

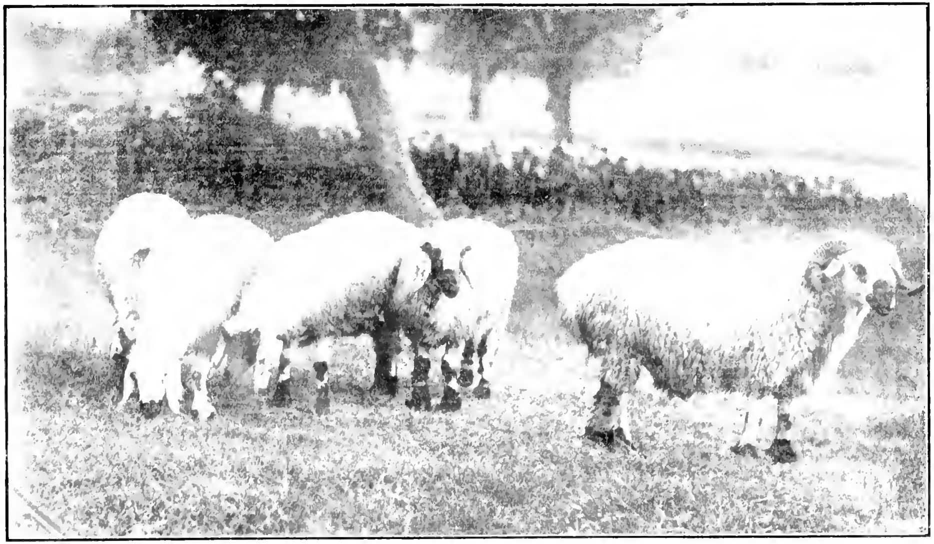
Herd Cow.	Height. Inches.	Girth. Inches.	Fore arm. Inches.	Shank. Inches.
No. 1	54	70	$13\frac{1}{2}$	$7\frac{3}{4}$
No. 2	56	72	$13\frac{3}{4}$	8

Donkey breeding.—In consequence of the failure of the supply of good jacks from the European Continent, Cyprus, China, Persia and Arabia, and the great difficulties in importing animals from America, it was decided to start donkey breeding at Hissar. The scheme conclusively proves that with careful selection, judicious breeding and rearing, we can breed donkeys better, more powerful and in every way more suited to our requirements at under one-third of the cost of indifferent ones in foreign markets. See Plates XXXII and XXXIII.

Mule breeding and mule rearing receive considerable attention on the Hissar Farm because of the great difficulty experienced in obtaining ordnance mules in the market. The work has been successful. The young mules bred on the Farm are superior to those obtainable in the open market, and have all been found fit for ordnance purposes (Plate XXXIV). The well-bred Punjab mule has no equal in the world for mountain battery purposes. A certain percentage of these mules are the produce of jacks bred in the Punjab.

Zebrule breeding was started at Hissar in February 1904. Four Zebra stallions (*Equus Burchilli*, variety *granti*) were received, which had been captured wild on the plateau of Central Africa. They soon became perfectly tractable and docile, and a series of most interesting experiments is now being carried on in

PLATE XXXVI.



A.J.I.

DUMBA RAM AND DUMBA-DECCANI CROSS-BRED SHEEP.

PLATE XXXVII.

A.J.I.

DUMBA RAM.

PLATE XXXVIII.

A.J.I.

Dumba-Hissar Cross-bred Sheep.

mating them with donkey and pony mares. The value of the Zebra for crossing depends to some extent upon immunity from certain diseases. Plate XXXV.

Sheep.—In the Ahmednagar District of the Bombay Presidency I conducted, several years ago, some successful experiments in sheep breeding. The district is an elevated plateau of the Deccan about 2,300 ft. above sea-level. It has a fairly comfortable climate and in normal years a rainfall of 25 inches. The soil varies from deep black cotton soil to shallow red or light coloured soil, the latter largely impregnated with lime.

The experiments were conducted with the object of testing whether the sheep of another country will thrive and adapt themselves to the altered conditions of climate, soil, etc., existing in other parts of India. With this object in view, I obtained Merino ewes from Queensland, Baluchistan, Rajputana and the Deccan and crossed them with Siah Band or Dumba rams, the fat-tailed sheep from the frontier. The average live weight of the various breeds is given below :—

	lbs.
Siah Band or Dumba rams	135
Do. do. ewes	105
Deccan ewes	82
Rajputana ewes	88
Merino ewes	94

Siah Band.—These are the fat-tailed sheep found in Baluchistan and on the Frontier. The wool varies in colour, but the sheep which I selected had white wool of fine quality. The rams and some of the ewes had speckled faces. The rams were hornless. These sheep are square and compact on very short legs. They soon become acclimatised to the heat and other deteriorating influences of the Deccan. The wool, however, got in time somewhat coarse and hairy, particularly on the shoulders. The ewes bred strong healthy lambs with a fair proportion of twins. They had plenty of milk and were good mothers. The lambs fattened rapidly and averaged when eight months old 103 lbs. live weight. Some fat lambs at five months old averaged 93 lbs. live weight. The mutton is delicate in flavour. In their native

country fat-tailed sheep are unaccustomed to any great heat, as their owners always arrange to move them from the plains to the highlands according to the seasons.

Deccan.—These ewes were carefully selected by me in various parts of the Deccan, care being taken that they were thoroughly representative of the breed and with white fleeces. They are hardy sheep, prolific breeders with abundance of milk. The Siah Band cross, on the Deccan ewes, was an undoubted success. The cross bred lambs, averaged when five months old 90 lbs. live weight. These crosses are hardy, come early to maturity and are short legged shapely sheep with much better and heavier fleece than the Deccani. The tail is thick at the root and resembles the Siah Band on a small scale. The average weight of pure bred Deccan fleece is 1 lb. and 3 oz. Average weight of fleece by Siah Band cross is 3 lbs. and 1 oz.

Rajputana.—Fifty selected ewes bought round about Jodhpur and Malwa where the best Rajputana sheep are supposed to be bred were brought to Ahmednagar. They took a long time to adapt themselves to the soil and climate and did not thrive. The cross with Siah Band ram was not successful. The lambs averaged, when five months old, only 40 lbs. live weight.

Merino.—Eleven pure bred merinos were brought from the Hunter River in Queensland. They arrived in emaciated condition, but rapidly put on flesh and produced lambs eight months after arriving in the country. The influence of the Siah Band ram on the offspring was most marked, the lambs taking on nearly all his characteristics. The fleece was completely changed from the compact close curled wool of the merino to a soft silky straight fleece. The lambs were very healthy and strong. The cross produced good mutton sheep.

The whole flock was grazed daily on light upland soil and housed at night when they received a ration of grain chopped guinea grass, lucerne and chaff mixed with some salt.

After several years' experience I came to the conclusion that the Dumba-Deccani cross was the best for the Deccan and

my flock eventually consisted of only pure Dumbas and Dumba-Deccani crosses.

The annual mortality seldom exceeded 2 per cent. I had no difficulty in disposing of fat lambs of this breed to butchers from Bombay, and some of the ram lambs eventually found their way to New Zealand, and were so much appreciated by breeders in that country that I received several applications for more.

My experiments prove that some indigenous Indian breeds of sheep can easily be improved both in mutton and wool producing qualities, but to obtain such results they must be liberally fed and intelligently crossed. Further, the success of the experiments both at Ahmednagar and Hissar with fat-tailed rams, leads me to think that they should always be used as a first cross in all future experiments in any part of India, as rams of this breed are hardy sheep, capable of standing extremes of climate and undoubtedly increase the weight of the fleece and greatly improve the mutton in weight and quality.

The success of the experiments at Ahmednagar suggested the advisability of starting similar experiments at Hissar where the flock is kept within a maximum of 300. It is almost certain that well selected ewes of any district where sheep are commonly bred can be advantageously kept on established Government Cattle Farms in the vicinity and crossed advantageously with Siah Band rams, one object being to distribute the best young rams in the vicinity. We might in this way do a great deal to improve the flocks in the neighbourhood of our cattle farms and may, in time as the sheep increased in size and value, teach the Indian shepherd to bestow more care and attention on his flocks.

THE TSE-TSE FLY IN INDIA.

By H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist.

The part played by tse-tse flies (*Glossina* spp.) in the dissemination of sleeping sickness and other diseases in Africa is now so well ascertained that fears have been expressed that should sleeping sickness be introduced into India, these flies might act as transmitters of the disease and India might be exposed to the ravages of a disease of equal virulence with plague. Cases of sleeping sickness have been reported in India and there is little reason to doubt that coolies returning from Uganda may have the organism in their blood; given these *Glossina* flies biting such infected coolies and then other persons, we have the beginning of an outbreak of sleeping sickness whose limits could not be foreseen.

In view of this possibility, efforts have been made to ascertain definitely if *Glossina* occurs in India. These flies are at present known from distinct tracts in tropical Africa only and they are well defined from other flies and easily recognised. Up to the present no fly of this kind has been found in India: when the enquiry commenced, very little was known about any biting flies except mosquitoes; at present a considerable number of other biting flies have been found, including several "Sand-flies," the many forest flies, and several flies of the house-fly type (*Stomoxys*, *Hæmatobia*, *Lyperosia*). These are in some cases very small and very difficult to study, but a good measure of progress has been made.* The fact that throughout this enquiry and in spite of the special efforts made

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* For an account of this, see Bulletin No. 7 of the Department, published by the Government Central Press, Calcutta.

to find *Glossina*, no fly of this kind has been found, is very strong evidence that *Glossina* does not occur in India. It is practically impossible that so large and distinct a fly, which lives by sucking the blood of cattle, etc., should have escaped notice, when so many inconspicuous species have been found ; it has not been possible to investigate every tract in India, but parts of Assam, Behar, Bengal, Gujrat and the west coast have been investigated specially.

There is the possibility that *Glossina* will be found, say in the North-West Frontier Province, or in Baluchistan, but its significance even then will be much less than if it occurred in India as a whole, and we have no reason as yet to fear that it occurs even in such tracts.

Apart from its occurrence in India, the possibility has been suggested that the fly might be *introduced*, and a question was recently asked in the House of Commons as to the precautions taken to prevent this. Expert opinion in India supports the idea that the possibility of the introduction of the fly is very remote ; the insect is a peculiar one, in that the adult fly does not arise from a maggot, which itself hatches from an egg laid by the fly, but the parent fly deposits a *full grown maggot*, which immediately hides in a suitable place and becomes a hard seed-like pupa from which comes the fly ; that is, the usual cycle of egg, maggot, pupa, fly is not found and the only two stages are the inactive pupa, and the fly. Were the volume of trade from Africa to India very large and were it to consist of fodder, or soil or farm yard manure or any such substances in which the pupa would be carried, then we might fear the importation of the pupa from which the fly might hatch.

This is, however, not a likely occurrence, and if the nature of the imports were at any time found to be such as would bring in the pupa, precautions would be possible.

In regard to the fly, no means whereby it could be introduced can be seen ; its distribution in Africa is extremely limited, and it will not leave its usual haunts except for short distances ; the possibility of its being carried to India is so remote as to be at present *negligeable*.

Even were *Glossina* to be introduced, say to Bombay, the chances against its successful establishment are enormous; one fly cannot carry on the race; even if it be a female, it produces only one pupa at a time and it cannot produce a whole brood at one time, which would be in one place and able to mate and establish a colony. It would be necessary to introduce a large number of flies, to keep them in one place where they could find each other and to provide abundant food, to establish a colony, which not improbably would succumb to the altered climatic conditions of India.

There remains the question of whether any biting fly in India is capable of transmitting the organism causing sleeping sickness and so of playing the part that *Glossina* does in Africa. This can be ascertained only by investigation, and the study of biting flies is the first step towards this.

A systematic study of biting flies has been and is being made, and we may hope soon to be in a position to know all the flies of importance and be able to rear them artificially and provide the material for further study. At present it is not known that any Indian fly will be capable of assuming the function of *Glossina;* there is every reason to believe that *Glossina* itself is absent from India, and we have no ground for fearing its introduction; it is also satisfactory to know that the matter is being very closely watched and studied, and that every precaution that can be devised will be adopted to prevent the introduction and spread in India of the tse-tse fly.

A CONTRAST BETWEEN THE AGRICULTURE OF EGYPT AND OF SIND.

By G. S. HENDERSON, N.D.A., N.D.D.,

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The lands in Sind are surprisingly like those in Northern Egypt which border the Northern Salt Lakes. Both tracts have a small annual rainfall, are deltaic in origin and each for cultivation gets irrigation from a large river. The soil in each case is alluvial and naturally fertile where here and there it is not impregnated with alkaline salts. In both countries these harmful alkaline salts may not be discovered until irrigation is applied and cultivation started. There owing to high air temperature, particularly at some seasons, excessive evaporation from the soil takes place. There is an upward flow of water to the surface carrying alkaline salts in solution and these are deposited at or near the surface as the water evaporates. In places excessive amounts of alkaline salts thus deposited cause absolute barrenness.

In Egypt practical measures have been taken to remedy such defects which I will describe later in this article. Meantime, the general agricultural conditions in each country may be contrasted.

I will describe the agricultural system of Egypt in a very general way. Upper Egypt is the country of "Basin" cultivation where large or very large "bunded" areas are filled with Nile water when the river is in flood in August. The bunded areas are emptied in October when the inundation has receded. Meantime, much silt is deposited on the submerged lands which

when they are dry enough on the surface are cultivated. They retain sufficient moisture for *Rabi* crops.

Mid-Egypt is a country of exceedingly intensive agriculture. Crop succeeds crop in rapid succession. No land is wasted. Crops are systematically rotated. Cotton is the most profitable crop. It gives a very large outturn when carefully cultivated.

In Lower Egypt and especially in that part of it in the North along the sea coast the land differs in quality. There are long stretches of yellowish desert-looking country growing stunted babul and scrub bushes of sorts. It is here that most of the large land companies are engaged. Their enterprise is encouraged by the high prices obtained for land in more favoured parts. With irrigation this land can be improved so as to become valuable.

Egypt has a fine agricultural population. There are over 1,000 people to each cultivated square mile. Waste lands are of course of considerable value to cultivators for grazing as in Sind. The land actually under cultivation or which can be brought under cultivation by irrigation has in recent years largely increased in value and this is due almost entirely to the profits obtained from cotton cultivation. The acre outturn of cotton is in Egypt calculated by Kantars. The Kantar is equivalent to 315 lbs. of seed cotton (seed and lint). The best land which can produce ten Kantars per acre is worth £1·50 per acre. Very ordinary land produces 3 to 4 Kantars per acre. Prices for Egyptian Cotton are not likely to decrease as the demand much exceeds the supply at present and land capable of growing cotton in Egypt is expected to keep at a high value. Moreover, the area of waste land in Egypt that can be brought under cultivation is small until irrigation facilities are improved. These are contemplated. With land so valuable as it is in Egypt the ordinary cultivator must necessarily be a hard worker. The ordinary tiller understands the principles of rotation and puts them in practice. Wherever cotton is grown in Egypt it is rotated and the general principle underlying the rotation is to have the ground well

covered during the preceding *Rabi* season with Egyptian clover or Berseem (*Trifolium Alexandrium*). This crop is sown in Autumn and gives several cuttings of excellent forage. It is ploughed in during March before the cotton is sown. It manures the soil, improves its physical condition and is otherwise an exceptionally good rotation crop with cotton and cereals. A common rotation on fair land is—

1st Rabi.	1st Kharif.	2nd Rabi.	2nd Kharif.
Berseem, sown in September, ploughed in March.	Cotton.	Berseem broadcasted in cotton.	Cereal crops such as Maize, Jowar, etc.

The land is always occupied by a crop and the hardening and cracking of surface soil so often found in Sind cultivation is thus prevented. Such ordinary manures as are available are given to the cotton. More elaborate systems of rotation are occasionally practised, but they are not commonly adopted. Wheat, barley, rice, maize, berseem and lentils may enter into a rotation with cotton but the latter is always the chief crop, and from start to finish the utmost care is taken in its cultivation. The land is got into fine tilth and thrown into ridges and the seed is carefully dibbled in by hand. The irrigation is regulated with care. The irrigation beds are small so as to control the inflow of water. The thinning, weeding, and spacing of plants are carefully attended to. In fact, splendid efforts are made to obtain the utmost economical yield from the land.

In contrast, I have to compare the Sindhi "Hari." He is not an assiduous worker and does not make the most of his opportunities. These are great. The Indus flows through the middle of his country and, unlike the Nile, gives water in the middle of summer just when it is not most required. Sind has an advantage over Egypt as regards natural drainage facilities. In Sind a certain amount of lift irrigation is required and is perhaps difficult considering the paucity of population. It is

probable that the Sind soils and climate assisted by irrigation are suitable for many of the crops which are so profitably grown in Egypt, but there are difficulties as regards labour at busy seasons. There is much land now lying waste which could be profitably brought under cultivation if we had a larger agricultural population.

Agricultural System in Sind.

The greater part of Sind is irrigated by old inundation canals which are filled on the rise of the Indus in May. The state of the flood regulates the time during which they remain filled as the majority of the canals take off from the Indus at right angles. A large area of land is irrigated by lift. The crops commonly grown under this irrigation are bajri, jowari, cotton and sessamum. The land is bare often for three or four years after a single crop, because the Haris have usually more land than they can deal with. Their cultivation is in fact limited to their ability to lift water. Culturable land which is allowed to be waste soon gets covered with jungle. When brought again under cultivation the jungle is cut down and the soil is softened by flooding. It is then ploughed and sown. The only work afterwards until harvest is to apply water. The Persian wheel or "Hurla" is generally used. One Hurla irrigates 8 to 10 acres according to the depth to water. It is generally worked day and night. The land thus irrigated is well above canal water and there is little trouble with alkali or "Kalar." The method of weeding cotton is characteristic of the slothful methods of the Sindhi "Hari." Volunteers come from the nearest villages and pull up the weeds when about 18 inches high and sell or use them as fodder. At the tails of the inundation canals and in low places which they command, rice is cultivated. This crop is most successfully grown from transplanted seedlings. Gram, etc., are taken as a second crop, but usually the cultivation is extremely careless. In lower Sind at the tails of the Nara, Fulleli and all along the South, the country in flood time is practically a lake, the irrigation water not being under control. Rice is

broadcasted in the water and the cultivation is very primitive and backward.

In the better lands when the floods go down wheat and Jambho (*Brassica Campestris Var*) are grown; also such pulses as mung, guvar, etc.

Cultivation on Perennial Canals.

The conditions are different from those on the inundation canals The main example is the new Jamrao Canal which has an excellent supply of water all the year round. It is fed from the Indus at Sukkur and of the 250,000 acres which it annually irrigates, 32 per cent. is by lift. The cultivation is not on the whole of a high standard. The land is mostly let by the Zamindars to tenants on the share system. During the early years of irrigation good crops of cotton, wheat, bajri, etc., were obtained by means of very heavy irrigation. Exhaustion followed and lands were allowed to be waste for periods of four or five years.

It was in this tract that the Agricultural Department introduced Egyptian Cotton. It occupied 5,250 acres last year. There is no doubt that the crop was sown largely on deteriorated land and the general outturn was poor although in particular cases good yields were obtained. In many instances very little care was given to the crop. The result was weak stunted plants which fell an easy prey to bollworm and other insect pests. On the other hand, on good land with fairly liberal cultivation the crop was over-irrigated and the plants developed vigour of foliage at the expense of flower and bolls. A sufficient number of examples was obtained both in the districts and on the Government Farm at Mirpurkhas to prove that on land in good condition with a fair amount of trouble Egyptian Cotton will give very remunerative results. The crop is not likely to be successfully grown over large areas in Sind until the traditions of the people are changed and the methods of cultivation very much improved.

There are in Sind thirty million acres which with irrigation would be available for cultivation. In 1905-06 the areas under different crops were approximately as under :—

	Acres.
Jowari	700,000
Bajri	900,000
Cotton	300,000
Rice	1,000,000
Wheat	600,000
Pulses	400,000
Oil Seeds	200,000

Reclamation of Alkali and Virgin Land in Egypt.

On land resembling that of Sind in physical and chemical characters the methods of land reclamation in Egypt are very shortly described below :—

In a new tract a complete system of irrigation and drainage is first laid out, the latter being considered of great importance as subsoil water is usually close to the surface. The land is divided in plots of two acres. Each is the unit of the system. Each plot is bunded round with the soil from the drains and is carefully levelled by means of a plough and scraper. If the work is done thoroughly, irrigation and drainage can be kept absolutely under control. Villages are built for each 500 acres forming the "Hod." A European Manager has charge of 6 or 8 "Hods." The parts of the lands above flow level are irrigated by means of a kind of lift which is a modification of the Archimedean screw. It is worked by one bullock or mule, and with a lift of 5 or 6 feet will irrigate 15 acres per day. When conditions are suitable, rice is usually grown for two years after reclamation and the land is considered properly reclaimed when it will grow a crop of Egyptian clover or berseem. In Egypt it is considered that the native cultivator is quite unfit to deal with the reclamation of either virgin or alkaline land, but when reclamation reaches a certain stage, he can be safely trusted not to allow land to deteriorate. At this stage, the land is either let to tenants or sold in small areas, the cultivator being bound down by strict rules as regards crops and clearances. The purchase price is

spread over ten years and is based on the average cotton crop. Sind seems to offer a promising field for similar work, and it is difficult to see how the standard of cultivation can be raised by any other means. It is certainly worth a trial on a small scale by Government in view of the proposed large extension of perennial canals in the near future. As a commercial undertaking, provided suitable terms are obtained from Government, it offers sound prospects to any concern having the necessary capital and technical skill. The labour problem presents some difficulties, but according to the report of the recent deputation to the Punjab, plenty of labour can be had on condition that the coolies get land to cultivate.

NOTES.

A Pest of Indigo in Behar.—Reports received from the Behar Planters' Association, show that the Indigo crop of Chumparan has this season suffered from an unusual pest. The terminal shoots of the plant, instead of growing normally, become twisted into a compact knot of leaves which prevents further growth. Planters state that plant growth is so checked that the yield of indigo is reduced sometimes by 50 per cent. or more and on considerable areas the crop has died outright. Investigation has shown that the curling of the leaf and shoot, with the cessation of growth, is due to the presence of a small insect, described in 1890 as *Psylla isitis* from specimens sent from Bengal (see Indian Museum Notes, Vol. II, No. 1). This small flattened insect pierces the leaves and terminal shoot, extracts sap and probably injects a poison, which causes the plant to produce abnormal growth. The result of the attack is the formation of the twisted knot of leaves in which the insect lives, and which gives an attacked field a peculiar appearance and dark colour which is easily recognised.

This pest has not been particularly noticed by planters during recent years but has been observed on the Pusa Farm and elsewhere in Behar during the past two seasons. It was also reported from Madras in 1905. It is not a new pest, but the insects finding large areas of suitable food plant have multiplied and have, therefore, become injurious.

One point of interest in the present enquiry is whether the insect is likely to recur or is sporadic. Possibly the pest was abundant and injurious in 1907 on account of favourable climatic conditions. There were prolonged periods of dry weather at times when rain usually falls and the total rainfall was under average.

The Indigo crop had, therefore, adverse conditions to contend with. The weakened crop, as usual, suffered more from these insects than a healthy crop would have done. Therefore, I consider that in normal seasons the same extent of loss need not recur. It is, however, possible that the altered conditions of indigo culture during the past two years may have influenced this outbreak. Formerly the Sumatrana plant alone was grown and this stood in the ground only from March to October. There was then no food for this pest from November to February, and this was probably the greatest check on its increase. During the past few years, the Java-Natal plant has been extensively grown. This plant is perennial and is left on the same ground for two years or longer. A particularly destructive insect thus finds suitable food all the year round and this probably led to increased numbers of insects and increased damage to crops of Indigo. If this is the case, we may expect considerable damage from this pest again in 1908. The crops should be carefully watched. We cannot at present decide the cause of the present attack.

The Sumatrana plant has, in all cases, suffered much more severely than the Java-Natal, though the latter is not exempt from attack. The dying out of Sumatrana Indigo in several cases was due to different causes of which the insect is only one.

Next year's cultivation will probably determine how far the cultivation of Java-Natal Indigo will help the propagation of the pest. If the losses in the Sumatrana plant are very severe, there will be another reason for abandoning this plant in favour of the Java-Natal which gives more dye per acre and for the time being is apparently more immune against plant diseases and insect attacks than the variety which has been long cultivated in Behar.—(H. M. LEFROY.)

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CATTLE-BREEDING EXPERIMENTS ON THE UPPER SHILLONG EXPERIMENT STATION.—The Annual Report of the Upper Shillong Experiment Station, for the year ending 30th June 1906, shows that the Farm has a herd of cattle for cross-breeding experiments. The herd consists of cross-bred English, Bhutia and Khasi

cattle. The first is commonly known as the Patna breed and was established about the time of the Mutiny by Mr. Taylor, Commissioner of the Patna Division. These cattle may now be looked upon as more or less fixed in type. They are also to a considerable extent immune from Rinderpest and other deadly diseases to which newly imported cattle readily succumb. Therefore, they can safely be used for crossing purposes and perhaps with considerable advantage in improving milking capabilities as the Patna cows are on an average exceptionally good milkers in comparison with any pure Indian breed. These cross-breeding experiments are interesting, and will, it is hoped, be continued till definite results are obtained.—(EDITOR.)

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USEFUL RESULTS FROM AN AGRICULTURAL SHOW.—An Industrial and Agricultural Exhibition was held in Bombay in 1905. In the agricultural section many ryots took keen interest in the various exhibits. I refer to this show now because it since produced many practical results. Such shows could, with advantage, be held annually in every province.

The show included a dairy with all up-to-date appliances, selected milk cattle, the best specimens of agricultural produce suitable for the country and for export, also agricultural machinery. There were also practical demonstrations in ploughing, water-lifting and such like, all of which may influence the improvement of Indian agriculture to a very considerable extent.

In reference to the interest taken by cultivators in particular sections of the show, the following special arrangements have been made by the Bombay Government :—

(i) On the Bombay Government Farms agricultural implements, which were seen at the exhibition, which are not generally used but which have been proved to be efficient, are kept in stock for purchase by agriculturists at cost price or by means of Takavi advances.

(ii) A small trained staff with boring apparatus will be maintained in each division to demonstrate to ryots where well water can be successfully obtained.

(iii) An officer of the Public Works Department will be placed on special duty to show how irrigation can be got economically from rivers and other sources of perennial supply by means of oil engines and pumps —(EDITOR.)

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EXPERIMENTS WITH MUSTARD SEED AT THE DUMRAON FARM.—In 1903, it was brought to the notice of the Inspector-General of Agriculture that the mustard and rape crop in Bengal was deteriorating owing to the inferiority of seed sown. Small samples of good varieties were obtained from other provinces and tried on the Dumraon Farm. These trials have been continued for four years and have given interesting results, which have been published in leaflet No. 6 of 1907, recently issued by the Bengal Department of Agriculture. The results show that the local variety is the poorest yielder of the varieties tried. Raipur mustard has given the best yield for four years with an average outturn of 3 maunds per acre above the local variety, while another variety from Jubbulpore in the Central Provinces is a good second with an average increased yield of $2\frac{1}{8}$ maunds per acre. Dr. Leather's analysis further shows that not only is the local variety a poorer yielder than Raipur or Jubbulpore mustard, but both these introduced varieties contain a higher percentage of oil than the local variety.

The crop can be grown in Bengal in the same year after paddy and probably elsewhere in many parts of India as a second crop if sufficient moisture remains in the soil in the Rabi season.—(EDITOR.)

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COTTON GROWING IN QUEENSLAND.—This Colony seems suitable for cotton growing. It is suggested that the best qualities of cotton can be grown on very large areas in this country. The harvesting time of the crops falls well within the dry season, so that picking is not interfered with by rain, which would spoil much of the crop. But labour is scarce and dear, and this may

interfere with commercial success. Mr. Bottomley, an expert regarding cotton cultivation, is, however, somewhat enthusiastic about the success of the cultivation of the crop in Queensland; and he believes that large areas of land now under maize might be occupied by cotton and that a large export trade to Lancashire might result without any probability of cessation. He thinks high class cotton can be grown in Queensland, cheaper than in any country in the world. The estimated cost of production is, however, put at £3 to £4 per acre. In India our cultivation and transport charges to seaports are much less than this. The Australian Government have been advised to establish an Experimental Station and a seed farm and arrange for the distribution of selected seed to cultivators.—(EDITOR.)

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AGRICULTURAL ASSOCIATIONS IN MADRAS.—A Central Agricultural Committee was established in Madras in 1905 and is connected with the Victoria Technical Institute. The Committee holds quarterly meetings. District Associations are represented. Bulletins regarding agricultural enquiries of special interest are published. By way of assistance the Government of Madras have recently sanctioned an annual grant-in-aid to the Committee. There are at the present time 22 District Associations and 46 Branch Associations in the Presidency. Many of these are dealing with the main agricultural defects of their districts and taking steps to remedy them. Several of the District Associations guided by the expert advice of the Agricultural Department have started, or are about to start, experimental farms with various practical objects in view. Apprentices for definite agricultural work are being trained for demonstrating improved methods of agriculture. The most definite lines of enquiry are as regards the introduction of new crops, improved methods of cultivation, better methods of preparing crude sugar, the improvement of fodder supplies, the manufacture of cheap improved agricultural implements and the encouragement of cultivation by irrigation from wells by oil engines and pumps.—(EDITOR.)

Some Agricultural Industries in Ceylon.*—In 1906, the agricultural industries in Ceylon continued chiefly prosperous. The trade in tea, cocoanut, cardamom, cocoa and citronella oil remained satisfactory. The value of the trade in citronella oil materially increased and this trade, owing to increased demand, will probably increase in Ceylon and India. A rise in value has stimulated the cultivation of camphor. The distillation of this product has been improved and thereby a larger yield obtained. The cultivation of rubber and tobacco has greatly increased. Improved methods of curing tobacco are receiving attention. Larger irrigation works for paddy are in progress and the general agriculture and horticulture of Ceylon seems to be at present in a very satisfactory condition.—(Editor.)

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Inoculation for Legumes.—Experiments carried out with the nodule bacillus isolated from the roots of pigeon pea (*arhar* or *túr*) show that for this crop no advantage is likely to result from bacterial inoculation in those parts of Northern India where the pulse is cultivated. It was tested both in Dehra Dun and Pusa. In sterilised soil, in which the bacilli naturally present had been destroyed, the method recommended by the U. S. Department of Agriculture gave a copious crop of nodules and correspondingly vigorous plants. Tried in the field, however, this advantage was lost, for both in soil that had not carried this crop for some ten years, and in soil that had borne it the previous year, no benefit resulted from the operation. The Dehra Dun plots were approximately one-tenth acre and the difference between the inoculated and non-inoculated plots was one per cent. in favour of the latter, an amount which is well within the limits of error of a field experiment. It is probable that the soils of Northern India contain a sufficient quantity of the nodule bacilli naturally to supply the needs of the commoner pulses grown.—(E. J. Butler.)

* Board of Trade Journal, No. 558, Vol. LVIII, 8th August 1907.

INDIGO WILT DISEASE IN BEHAR.—Several cases of this disease have been reported in Behar recently. The cause is a fungus, *Neocosmospora vasinfecta*, well known as causing similar diseases of cotton, water melon, cowpea, bhinda (*Hibiscus esculentus*) and other plants in the United States. This fungus can only be distinguished from several other allied soil fungi in its perfect fruiting condition, and the recent discovery of this condition for the first time in India leaves no doubt that the disease has reached this country. Besides indigo, gram and rahar are affected in Behar. The parasite lurks in the soil, being able to remain alive for at least three years in fallow soils. It enters through the young roots and penetrates the base of the stem. As a result of interference with the water supply the plant dries up. Both Java and Sumatrana varieties have been attacked. The only hope of checking diseases of this nature is by the discovery of resistant varieties, and it is therefore clear that an important part of future work on indigo will be the separating into pure races, where this is possible, of all the varieties that can be obtained in India or abroad, and testing their resistance to the disease. Land which has shown this disease should not again grow indigo, rahar or gram for at least three years.—(E. J. BUTLER.)

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THE DESTRUCTION OF DATE PALMS BY TAPPING.—It is well known that great mortality occurs in Indian date palms in some districts as a result of tapping for the production of toddy and palm sugar. This has been referred to in the Report of the Indian Excise Committee recently published (p. 69, paragraph 169). It is stated to be a matter which urgently demands notice, particularly if the development of palm sugar manufacture should be extended. The ruthless destruction of date palms by tappers is said to be most evident in Madras. In Bombay less injury is caused and the least in Bengal. In a letter from the Secretary to the Excise Committee, it is stated that in Bengal the incision is well below the head of the tree, roughly triangular, with its

point upwards, and comparatively shallow, though broad (Fig. I, B.). In Bombay the cut is oval and nearer the head (Fig. I, C.). It is frequently deepened until it passes through the stem. In Madras the incision is right under the head and is triangular as in Bengal, but with the point downwards (Fig. I, A.). It is well to mention, however, that other accounts of the methods of tapping in vogue in different Provinces do not altogether agree with the above. The Jessore district of Bengal for instance appears to employ the system here described for Madras.

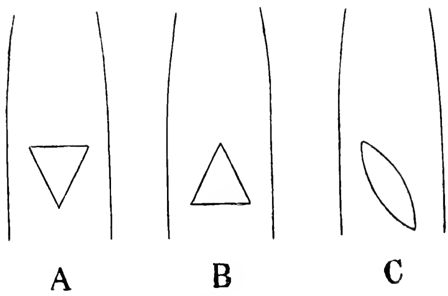

Fig. 1.

It is possible that a consideration of the anatomy of the palm stem may afford a clue to the explanation of these results of tapping.

The leaves of palms are bunched together at the crown. On a full grown tree only those lowest on the bunch are active in contributing to the support of the tree. These are the fully expanded green leaves, which are actively engaged in manufacturing starch and other food, and are directly or indirectly the source of the sugary substance in the toddy juice. Above them, and enclosed in the bud by a series of tubular sheaths, are a number of young leaves, the youngest leaf and the growing point being sunk in a little depression at the apex of the stem.

The fully active leaves are supplied with water bearing dissolved salts, from the roots, through vessels grouped in bundles.

These are, in palms, as in all the division of plants to which the palms belong, scattered through the thickness of the stem, not arranged in definite rings towards the surface. Hence it is that palms cannot be killed by "ringing," and that they are enabled to stand the severe wounds inflicted on them by the tappers. It is, however, essential for the well-being of the tree that the main vessels going to the active leaves should be as little interfered with in the operation as possible.

The vascular bundles of palms are peculiar in several respects. In a transverse section of the stem they occur crowded together in large numbers near the surface, and successively diminish in numbers and increase in size towards the centre. In the outer layers the bundles contain no active vessels but are mere fibrous threads. On tracing these up they are found very gradually to sink into the interior of the stem until they approach the leaves, when they curve rapidly out again into the leaf to which they belong. As they become more internal, vessels are found, gradually increasing in size until they reach a maximum at the deepest part of their course. Hence the general statement can be made that the vessels run rapidly from the leaf in a curved path towards the centre of the stem, and from there pass downwards and very gradually outwards towards the fibrous layer near the surface of the stem. As the bundles approach this layer, their vessels disappear, and the layer itself is formed only of fibrous continuations of the bundles. In this course union of one bundle with another is rare, each pursuing an individual course. The middle vessels of each leaf reach the centre of the stem in their inward curve, while the lateral vessels penetrate a shorter distance. The former also run down approximately in one plane while the latter run in a spiral to right or left and reach the fibrous layer in a position not directly under that in which they enter the stem.

Hence in a longitudinal section of a palm stem the middle vessels of the leaves may be imagined somewhat as in the diagram (Fig. II). The crossing which is shown is due to the fact that the vessels of the youngest or uppermost leaf are

always the most external, and hence vessels running to any one leaf must cross those going to leaves higher up.

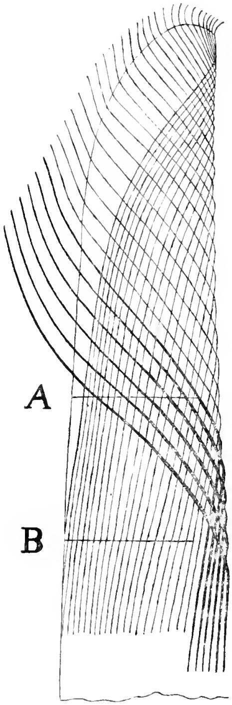

FIG. II.

It appears to be evident from the diagram that a cut at **A** directly under the crown of leaves, as in the Madras system, will divide a number of the main vessels going to the actively functional leaves, which are those lowest in situation on the crown. It will also divide them in their course from the leaf to the centre of the stem, a part in which they are large and active. A cut at **B** on the other hand will divide the vessels going to leaves still enclosed in the bud and, therefore, not yet functional, and will divide them in their lower part as they approach the fibrous layer towards the outside of the stem, where the vessels are small and probably of little importance. The result is that a cut at **A** may cause serious stoppage of the raw food and water supply to the manufacturing leaves, and this will be the more serious the deeper the cut and the larger the portion of circumference it involves.

On the other hand, since the flow of toddy comes from the divided vessels, it seems probable that the maximum outflow will be produced by a cut at **A**.

The truth of these suppositions can only be tested by experiment. It is, as a matter of fact, extremely difficult to trace out the course of any large proportion of the vascular bundles, and to decide exactly what injury will be caused by a cut at a particular spot. They cross and intertwine in a most confusing manner, owing chiefly to the oblique course of a large proportion of them. Lateral connections between the different bundles would be of importance in providing an alternative path for the

sap in a divided vessel, but they are stated, and appear, to be rare. Still it seems likely that there must exist some such path by which part of the water current can be deflected around large wounds. It is difficult otherwise to explain what advantage can result from the practice of tapping alternately different sides of the tree, which is nevertheless almost universal.

Without entering into these anatomical questions, it is certain that much useful information could be derived from systematic experiments.

In the first place, it appears necessary to test by direct experiment the effects on the active leaves of wounds of different depths and areas, inflicted directly under the crown and also at a little distance further down. The shape of the wound should also be varied, the triangular cuts of Madras and Bengal with the deepest portion above and below respectively, and the oval cut of Bombay being compared. Other incision such as spiral or V-shaped might also be tried. In the next place, the amount of juice obtained with different types of incision requires investigation. Finally, it would be necessary to see how far the two requirements avoidance of serious injury and extraction of the maximum amount of juice, can be reconciled. It is clear also that the methods of tapping actually in use require much more careful examination than they have received. Much time would be saved by working from the known to the unknown, and it is scarcely possible to plan a detailed series of experiments in tapping until local practices have been fully investigated.—(E. J. Butler.)

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Bombay Cotton Seed Cake.—Dr. Voelcker, in his Annual Report to the Royal Agricultural Society of England for 1906, draws attention to the fact that the amount of sand in Bombay cotton cake has increased somewhat of late, or in other words, the seed used is rather more dirty.—(J. Walter Leather.)

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Sorghum Poisoning.—In view of the number of cases of sorghum poisoning which occur in India, the following note,

taken from the July Number of the Queensland Agricultural Journal, may be of interest :—

"A very important discovery with regard to sorghum poisoning was made by Dr. S. Avery, Chemist of the Nebraska Agricultural Experiment Station, who has shown that Carbohydrates (sugars, as glucose, milk sugar and molasses) act as an antidote against the poisonous action of prussic acid and the prussic acid yielding glucoside. The presence of sugars in the first place retards the action of the enzyme in liberating free prussic acid ; and again, prussic acid unites with sugars to form less poisonous addition products. Dr. Avery recommends, therefore, to give to an animal suffering from sorghum poisoning, in a case that its condition still allows medical treatment, a strong solution of glucose syrup or molasses ; or, again, a large quantity of milk. Actual experiments have shown that an animal could be given a large dose of pure prussic acid, up to three times the fatal dose, if glucose was given at the same time ; the animal became very sick, but still recovered. Farmers have, therefore, a fairly safe remedy in molasses for these cases of poisoning. Treacle is a cheap and valuable cattle food in almost any country, especially for sweetening bhusa, chaff and such like fodders."—(A. G. Birt.)

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South African Locust Fungus.—As mentioned in a former issue (*Agricultural Journal of India*, Vol. II, Part 2, p. 208, April 1907), experiments with the fungus received under this name from South Africa have failed to show that it is capable of killing Indian locusts and grasshoppers. A recent publication of the Transvaal Department of Agriculture (Leaflet No. 5, Division of Botany, 1907), helps to explain this failure. It is shown that the true natural locust parasite in South Africa is a different fungus ("*Empusa Grylli*") to that which has been distributed under this name ("*Mucor exitiosus*"). The former, while a deadly enemy of locusts, has not so far been cultivated artificially and hence is not available for systematic use against these pests. The latter is probably quite harmless to locusts and

most likely only grows on their dead bodies after they have been killed by the former or have died from natural causes. As the latter is the one which has been widely distributed for testing in India and elsewhere, it is not surprising that no good results were obtained. It would be interesting to know whether the true locust parasite "*Empusa Grylli*" occurs in India, as up to date it has not been found. Any one who observes locusts or grasshoppers dying in numbers from no evident cause, would confer a favour by immediately sending specimens of the dead locusts to Pusa for examination. Unless, however, some means can be found of cultivating the fungus artificially, it will not be practicable to attempt to disseminate it on a large scale.—(E. J. BUTLER.)

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THE STRENGTH OF WHEAT FLOUR.—In the *Journal of Agricultural Science*, Vol. II, Part 2, of 1907, Mr. T. B. Wood details the results of an experimental investigation on the cause of the strength of wheat flours. To what this strength is due is a matter of much discussion. Chemical examination of flours has so far led to very little increase of our knowledge of the subject. Since Biffen has shown that "strength" is a Mendelian character, that is to say "hereditary," the question of obtaining strong wheats seems to rest in the hands of the plant breeder.

The size of the loaf of course depends on the strength of the flour from which it is made. Mr. Wood shows that the factor which primarily determines the size of the loaf which a flour can make is quite distinct. Flour contains a certain amount of sugar, but it is also capable of forming more sugar from the starch which it contains by reason of its "diastatic power." This "diastatic power" is due to the presence of the ferment diastase which can convert starch to sugar. The paper in question shows that the size of the loaf depends in the first instance on the amount of sugar contained in the flour together with that formed in the dough by "diastatic action." Mr. Wood proposes to measure these amounts by incubating flour with yeast and water, and collecting and measuring the carbon dioxide gas

evolved during 24 hours. It is the amount of gas evolved in the latter stages of fermentation which more directly determines the size of the loaf. It is probable that the shape of the loaf depends on the physical properties of the gluten.—(H. E. ANNETT.)

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LOSSES IN MAKING AND STORING FARM YARD MANURE.—In the *Journal of Agricultural Science*, Vol. II, Part 2, Mr. T. B. Wood discusses the causes which give cake-made dung a high reputation among practical men. The author's experiments seem to establish this reputation from a chemical point of view, and they offer us the probable explanation. He shows that there is much more ammoniacal nitrogen in dung from cake-fed animals than from animals fed on a poor diet. This form of nitrogen is readily available for plant food and produces a vigorous effect on the crops to which it is applied. At the same time cake-made dung is found to be more readily fermentable than dung made from poorer foods. Consequently it is more liable to loss during storage, and this loss falls chiefly on the readily fermentable ammoniacal nitrogen.

The author concludes that in ordinary good farming one-half the nitrogen of purchased foods is recovered in the dung.—(H. E. ANNETT.)

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PRODUCTION OF TEA IN INDIA.—The annual statistics of the production of Tea in India have recently been published by the Commercial Intelligence Department from which the following main features are taken.

The total area, 531,808 acres, is only slightly greater than that of the preceding year, but the increase since 1885 has been 85%. The total production now stands at 240 million pounds, of which nearly the whole is exported; the United Kingdom is the chief customer and takes 73%. The increase in production since 1885 is 236%. The quantity of green tea made is only nominal and does not appear to be increasing. The quantity of tea consumed in India is estimated at 7 million pounds. The prices

of the last year were appreciably better than in 1905 for all qualities and in all districts. The capital invested amounts to about 21·8 crores of rupees, and the number of persons employed is close on half a million.—(J. WALTER LEATHER.)

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INDIAN DYES.—In a recent Memoir* of the Asiatic Society of Bengal, Mr. E. R. Watson details the results of some interesting experiments which he has made on the fastness or permanence of indigenous dyes of Bengal when exposed to the influence of light, soap, alkali and acid and which he has compared with pure artificial dyes. He finds that some, such as "bakalu" (ex *Cæsalpinia sappan*), "manjista" (ex *Rubia cordifolia*) and "catechu" (ex *Acacia catechu*), whilst not ranking so high as turkey red, compare very favourably with the great majority of synthetic products. Latkan (ex *Bixa orellana*), red sandal (ex *Pterocarpus santalinus*) and padauk (ex *Pterocarpus dalbergioides*) fade so readily on exposure to light that their value is only nominal, whilst some dyes such as "turmeric" (ex *Curcuma longa*), "kusum" (ex *Carthamus tinctorius*) and "palas" (ex *Butea frondosa*) are extremely readily affected by all agencies.—(J. WALTER LEATHER.)

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LEAF MANURE.—*Apropos* of the value of leaves as a manure, the February issue of the Queensland *Agricultural Journal* states that it has been proved by Grandeon and Henry, two of the Nancy Professors, that besides serving as food for earthworms and other organisms, the activity of which keeps the soil porous, friable and superficially rich in nutritive mineral matter, dead leaves fix atmospheric nitrogen to the extent of 12 to 20 lbs. per acre annually.—(T. F. MAIN.)

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COTTON IN WEST AFRICA.—The British Cotton Growing Association have issued their Second Annual Report describing the experimental work which they have carried out on the West

* Vol. II, No. 3, price Re. 1.

Coast of Africa. It appears that the Association have seven plantations in the three districts of Western Africa, *viz.*, Southern Nigeria, The Gold Coast and Lagos. The Report does not take a very optimistic view of the prospects of cotton in those parts, especially in Southern Nigeria where a species of insect, one of the bollworm class, has wrought havoc among all varieties, native as well as exotic. The cotton seems to have suffered considerably from a number of insects and fungoid diseases of which the "bollworm" and "blight" have done the most damage.

Judging from the few results obtained up to date, none of the varieties of Egyptian cotton are likely to prove successful, trials have been made with Yennovitch, Abassi and Metafiffi with very disappointing results. A few of the native varieties have given moderate outturns, but some of the Americans have given much the best results.

The proportion of lint to seed appears to be fairly satisfactory in most cases and prices equivalent to those current for Middling Americans have been obtained.

While the report on the whole takes a somewhat gloomy view of the future of the cotton industry on the West Coast of Africa, it must not be forgotten that the experimental work is still in its initial stages, and the results obtained up to date cannot be regarded as altogether final.—(T. F. MAIN.)

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MADURA CATTLE SHOW, 1907.—This Show is held in connection with an old established annual fair to which large numbers of cattle are brought. In May 1907, about 16,000 cattle were brought for sale. Selections were made from these and only the best animals were admitted into the Show enclosures. These consisted of—

68 pairs of bullocks,
12 breeding bulls,
4 cows,
92 Jellicut bulls.

The Show was organised by the Madura District Agricultural and Industrial Association, assisted by the Agricultural, Revenue

and Police Departments. It was not very successful this year and it is clear from the report that the exhibitors were somewhat suspicious as regards the objects of the Show. The Committee are bent upon popularizing it, and prejudices will disappear in time. At these large annual fairs, which are common in many parts of India, there are great opportunities for demonstrating agricultural facts which may prove of great value to practical agriculturists. It would, for instance, be easy to show by lantern slides the life histories of particular harmful insects, and it would not be difficult to describe the actual damage done and give an estimate of actual loss and the means of combating it. The Agricultural Department could moreover have an exhibit stall for specimens of crops, implements and such like, which had been proved to be specially valuable in particular districts, with an educated attendant in charge fully qualified to explain all circumstances to the people in their own language. The value of demonstrations of this kind cannot be questioned

In some parts of India it is, I know, very hard to overcome the prejudices of agriculturists. In time, antiquated traditions will disappear among agriculturists everywhere. The Association will doubtless aim to extend the scope of the Show to include exhibits of all kinds of agricultural produce—sheep, goats, buffaloes and particularly young stock.

In the Canal Colonies of the Punjab the new Colonists show great emulation in exhibiting, at an annual fair, the produce of their farms, their cattle, horses, etc. The Lyallpur Fair, for instance, is really a "week" which combines, in a very practical way, business with pleasure. The Colonists, encouraged by the Colonization Officer, are uncommonly keen on sports, but they are also uncommonly keen to sell the produce of their lands and surplus stock to the very best advantage, and both objects are attained. I suggest that the Lyallpur fair provides an object lesson for other parts of India.

It is suggestive that 92 of the entries at the Madura Show were bulls which are reared specially for "Jellicuts or Thamashas." A game is played with them which may be described as bull

bartering. The more spirited and fierce the bull is the more he is valued. I believe that if the Executive Committee took a special interest in these and other pastimes and encouraged them, it would be easy to develop the Madura Show into a sound annual agricultural exhibition. If the Sahib gets in touch with the people over their sports and pastimes, he will easily influence them in other ways.—(EDITOR.)

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THE CULTIVATION OF MANGEL WURZEL.—(Agricultural Department, Bengal, Leaflet No. II of 1907).—Good results have been obtained in several parts of Bengal, with this crop, when grown in the Rabi season with irrigation. A rich loam or clayey loam soil is required,—also good cultivation and liberal manuring. A heavy dressing of cow-dung and two to four maunds of common salt are recommended. Two to five seers of seed should be sown per acre at any time from November to February, in rows two feet apart. The plants should be singled out a foot apart when they are fairly established. The crop is harvested when the leaves turn yellow, the roots being pulled by hand. They can be stored in a heap under cover and when fed to cattle should be sliced with a chopper. The leaflet makes no mention of the great obstacle to the cultivation of this crop, its liability to destruction by insects, which attack it seriously in this country. The crop, at Pusa last season, weighed less than 20 tons per acre or about half a really good crop in England.—(EDITOR.)

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CONSERVATION OF MANURE.—(Agricultural Department, Bengal, Leaflet No. 7 of 1907).—This leaflet describes how the dung and urine of cattle should be conserved. It is pointed out that the phosphoric acid is in the dung and the available nitrogen and potash in the urine, and as these are the most valuable constituents in manure, they should not be lost. Cattle stalls should, therefore, be so made that the urine runs off into a receptacle from which it is added to the manure heap or pit or at once applied to the land. A pit is recommended for the storage of manure both liquid and solid. In districts of heavy rainfall the pit should be

roofed, and to prevent excessive heating, manure should be packed down tight in the pit as occasion requires. If a manure heap must be made in the open, it should be mixed with earth and covered to a thickness of six inches with loamy soil.—(EDITOR.)

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ENSILAGE FOR FODDER.—(Agricultural Department, Bengal, Leaflet No. 8 of 1907).—A statement of the processes occurring in the making of ensilage and the temperatures, etc., required to make the best quality. Directions are given for the preparation of simple silos in two forms, the stack silo, the pit silo. The use of a thermometer in determining temperatures is recommended and careful directions are given to prevent damage from water. Maize, cut when nearing maturity, and juwar, cut when the grain is formed but not ripe, are recommended for ensilage and the danger of poisoning from young juwar is pointed out.

The leaflet contains valuable information scarcely suited to any but a very advanced farmer, who could understand the use of the thermometer and the term 110° F.—(EDITOR.)

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BONEMEAL AND SALTPETRE AS A MANURE FOR PADDY.—(Agricultural Department, Bengal, Leaflet No. 10 of 1907).—Selected raiyats of the Burdwan Raj were supplied with bonemeal and saltpetre for application to paddy : the results obtained show that, where the manure was used, the average outturn per bigha was 13·4 maunds of grain and 18·2 maunds of straw, against 6·5 of grain and 9·9 maunds of straw from unmanured land. The cost of the manures was Rs. 4 per bigha (1 maund of bonemeal, 10 seers of saltpetre), while the increased return is Rs. 25, showing a clear net increased yield of over Rs. 20 per bigha. There is no doubt that experiments have proved that bonemeal has a special value on the paddy fields of Bengal in comparison with arable areas in other Provinces.—(EDITOR.)

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RUST IN THE PUNJAB, 1906-07.—The cold weather was longer than usual with much rain and a very large number of cloudy

days in the last fortnight of February and in March. The consequence was that the crop was late by quite a fortnight by the end of March and there was a considerable amount of rust. The weather changed on the last day of March suddenly becoming very hot for ten days. The result was that the crop ripened unnaturally fast and produced weak and shrivelled grain. This view is, I think, fairly well confirmed by the fact that the late wheat suffered most and in many cases the ears were quite barren.

As regards the part played by rust, I think it would be a very difficult thing to separate out its specific share of the damage. Where it came in was, I think, in *weakening* the plant and making it less fit to cope with the sudden change of weather. The same occurrence took place some ten years ago, but I cannot give definite particulars. All I know is from hearsay. I consider that the crop here under similar weather conditions would be very liable to again suffer in the same way. It is fairly certain that rust was not the *sole* factor in the loss but I am quite sure that it played an important part in it. In the Colonies the total shortage is probably from ten to fifteen per cent. on the first sown crop and from twenty to thirty per cent. or even more on the later sown crop.

I think that if the weather had warmed up gradually we would probably have had a normal crop. My opinion is that an ordinary healthy crop protects itself from the effects of the sun's heat by evaporation, but that a rusted crop has not the same evaporative power and consequently suffers badly. I think a healthy crop might have resisted a sudden change of temperature. If so, the whole damage was caused by rust. We have unfortunately not enough data to do anything else but guess, but I think the two factors were undoubtedly *weather* and *rust*, and their separate effects cannot, I am afraid, be isolated.—(S. MILLIGAN.)

LITERATURE.

Manual of Irrigation Wells. By E. A. Molony, I.C.S., *Collector of Gorakhpur.* (Bulletin No. 22 of the Department of Land Records and Agriculture. United Provinces. Price, 12 annas.)

In this manual Mr. Molony goes into great detail when discussing the principles which underlie the science of well-boring. Having first described these in popular language, the author proceeds to treat the subject in a thoroughly scientific manner, devoting separate appendices to the more important theories involved. Much space is also given to detailed instructions as to how each piece of work, in the construction of different kinds of wells in the alluvial tracts of Northern India, is to be carried out; it is probable that the ordinary reader, unaided by ocular demonstration, will find this part of the book somewhat difficult to follow.

The substance and material contained and discussed in the book are all that could be desired, but Mr. Molony and his publishers can scarcely be congratulated upon the way in which the book has been produced; while reading through the text one cannot but be struck by the want of differentiation between that which is important and that which is comparatively not so. In other words, there is nothing to catch the eye of the reader, and hence he has to give the greatest attention in order to follow the explanations and arguments which are laid down. If only a few of the more salient points, such as the definition of spring and percolation wells, had been given in bold type, the value of the book would have been much enhanced.

There is, in fact, a want of crispness about the whole get up of the book which has the effect of minimising to a very great degree the impression left on the reader's mind, which is fully merited by the matter discussed in the text.—(T. F. MAIN.)

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THEOBROMA CACAO OR COCOA. ITS BOTANY, CULTIVATION, CHEMISTRY AND DISEASES. BY HERBERT WRIGHT.

MESSRS. A. M. and J. Ferguson have recently brought out this work and through it Mr. Wright has given us a useful contribution on this important industry. The author has endeavoured throughout to collect all useful information upon the subject and to present to the reader in a concise and systematic manner a full account of the Cacao industry as at present carried on, not only in his own country of Ceylon but also in all the Cacao producing countries of the world. The publication covers the whole field of this industry. The author commences with a careful summary of the world's Cacao producing countries together with the climatic and other conditions prevailing therein and then proceeds to describe the varieties of this crop which are grown in each. Mr. Wright then goes on to treat his subject from all its different aspects, first, as regards methods of cultivation, with reference to which he discusses at considerable length such important points as soils, shade, pruning, grafting, harvesting, curing and the like. This portion of the book is eminently suited for purposes of reference, the various practices being briefly but sufficiently discussed under the headings of each particular country concerned. The writer next devotes a chapter to the Chemistry of the Cocoa tree, in which he gives numerous analyses showing the relative amounts of plant foods removed by each portion of the plant, whether stem, leaves or fruit.

This serves as a useful introduction to a careful essay on the important subject of manuring. Probably the planter will find these chapters, *viz.*, Nos. XII and XIII, the most interesting as the author fully illustrates his views and contentions with the aid of experimental results obtained in countries distributed all over

the world. A chapter on insects and fungoid diseases follows with useful suggestions and instructions as to how these enemies are to be resisted and combated.

Mr. Wright appropriately concludes his book with a summary of the trade and present position of the Cocoa Industry in which he amply demonstrates by means of figures how rapidly this industry is increasing and developing not only in old Cocoa-producing countries but also in new regions hitherto unknown to Cocoa cultivation The text is suitably illustrated with 18 plates showing typical scenes in Cocoa cultivation —(T. F. MAIN.)

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REPORT OF THE AGRICULTURAL STATION, PALUR, MADRAS, FOR 1905-06. BY C. A. BARBER.

THE First Scientific Report of the Palur Agricultural Station, Madras, has been received at the office of the Inspector-General of Agriculture in India. Mr. C. A Barber, Economic Botanist to the Government of Madras, has prepared this Report and has devoted himself mainly to giving a justification for the establishment of an Experimental Farm in the South Arcot District. Mr. Barber explains that the object of starting this Station was chiefly to study the groundnut and sugarcane crops. The former ranks second only to paddy in South Arcot and the latter provides an industry which has greatly declined in recent years. Mr. Barber makes out a strong case for the urgent need of scientific assistance in which these crops stand. During the last 50 or 60 years, the groundnut industry has been subject to great fluctuations in point of area which steadily increased until 1892 when it rapidly declined only to rise again in 1899, and to continue increasing till the average acreage under this crop during the period 1901—1906 was no less than 300,000 acres. An investigation into the cause of these fluctuations together with a careful study of the more serious diseases and insect enemies of this crop is now being systematically carried out.

Sugarcane, while never occupying very large acreage, has always been grown in all parts of the district, but the area under

this crop has greatly fallen off within recent years. The fate of the industry has always been closely bound up in that of the European Crushing Mills, and the low prices ruling for sugar during the last few years has compelled the owners either to stop working these mills or offer lower prices for the canes and hence cultivation has decreased. The only remedy for such a state of affairs is to produce a better quality of cane and now there is a great demand for good seed. It is hoped, therefore, that the farm may prove a useful medium for the supply of the best seed cane. —(T. F. MAIN.)

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ALCOHOL AS FUEL. BULLETIN NO. 277 OF THE UNITED STATES DEPARTMENT OF AGRICULTURE. BY LUCKE AND WOODWARD.

THOSE interested in oil or gas engines will find much interesting information in Bulletin No. 277 of the U. S. Department of Agriculture, recently compiled by Messrs. Lucke and Woodward. Though the Bulletin is written with the primary object of discussing the prospects of alcohol as a motive power, yet there is a great deal of detail treating of the construction and mechanism of all the more important types of engines now upon the American market. The Bulletin is written with the object of giving assistance to the American farmer who is presumed to have little or no technical training in engineering. The choice of language and use of terms is, therefore, of a simple, easily understood nature. The text is illustrated throughout by diagrams and should be carefully read by those who intend to purchase such an engine. The use of alcohol as a fuel has been rendered possible through the abolition of the duty previously levied upon this article. It appears that the immediate prospects of alcohol replacing kerosene, gasoline or the like as a fuel for these engines is somewhat remote, but there seems a distinct future for it in those districts where transport of fuel is expensive. In such out-of-the-way places alcohol possesses a great advantage over these other fuels in that it can be manufactured on the spot from annual crops such as the molasses of sugarcane or from maize. The cost

of manufacturing a gallon of alcohol from these products is estimated at 6 annas or less. The erection of a small still does not seem out of the way, especially in parts where the co-operative system has come into vogue.

Recent trials with motor cars show that alcohol cannot hope to compete with gasoline or kerosene at present prices, but the chief advantages claimed for it over these fuels is the absence of smell and the higher temperature at which ignition takes place, thus rendering great security from fire. The latter character eminently stamps alcohol as a most desirable fuel to use in ships. It appears that engines constructed for gasoline or kerosene can be run on alcohol quite well without any material alteration in their construction, but greater efficiency is secured if a few minor adjustments are made.—(T. F. MAIN.)

NOTICE.

THE Memoirs of this Department, dealing with scientific subjects relating to Agriculture, will appear from time to time as material is available. They will be published in separate series, such as Chemistry, Botany, Entomology and the like. All contributions should be sent to the Editor, the Inspector-General of Agriculture, Nagpur, Central Provinces, India. Contributors will be given, free of charge, fifty copies of their contributions.

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STORAGE